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ENVIRONMENTAL INDICES FOR THE LOS ANGELES DATABASE

D. G. Malcolm, et al

California State University

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Washington Environmental Research Center

March 1975

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ENVIRONMENTAL INDICES FOR THE LOS ANGELES DATABASE

by

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The project team surveyed federal, state, county and city agency data sources and located the data needed to implement a set of indices similar to the Initial System of indices designed and developed for the County of San Diego by the IREM project in 1973. Because the CAB database is organized by census tract the problem had to be dealt with of interpolating environmental data, which is not organized by census tracts, to the census tract breakdown of the area.

A two-state statistical analysis technique, called "matric analysis", is described. This technique identifies urban areas that share many common characteristics, including the environmental qualities measured by the indices. Government policies and programs that meet the needs of each type urban area are then developed.

The relationships between energy use and environmental problems are described. Various organizational problems noted by the project team that prevent effective environmental information systems and management are reported.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Environments Planning Indexes (ratios)	Data base Analytic techniques	5B

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The purpose of the project was to expand the scope of the analyses being made by the Community Analysis Bureau (CAB) of the City of Los Angeles to include measures of environmental quality. The scope included measures of air quality, noise, water quality and quantity, land use, handling of solid waste and energy use.

The project team surveyed federal, state, county and city agency data sources and located the data needed to implement a set of indices similar to the Initial System of indices designed and developed for the County of San Diego by the IREM project in 1973. Because the CAB database is organized by census tract the problem had to be dealt with of interpolating environmental data, which is not organized by census tracts, to the census tract breakdown of the area.

A two-stage statistical analysis technique, called "matrix analysis", is described. This technique identifies urban areas that share many common characteristics, including the environmental qualities measured by the indices. Government policies and programs that meet the needs of each type urban area are then developed.

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The research was performed by a research staff from California State University, Los Angeles with Donald G. Malcolm, Dean, School of Business and Economics, serving as Principal Investigator and Dr. John M. Hemphill, Director of the Bureau of Business and Economics Research serving as Project Director. Dr. John Gessford of the Bureau of Business and Economics Research was responsible for the final preparation of this manuscript. Donald Macdonald prepared the subsections on noise and air. Phillip Hanson prepared those on land use and water. Dr. Marc Epstein, Associate Professor, CSULA, prepared the subsection on solid waste.

The matrix analysis and database concepts described in this report would not have been possible without the extensive efforts of Robert E. Joyce. His seven years as director at the City of Los Angeles' Community Analysis Bureau provided the guidance for the development and interpretation of the urban analytical tools necessary for this study.

Craig Avery of the City of Los Angeles' Community Analysis Bureau wrote the sections describing CAB's development, present methodology and proposed application of the environmental database. Invaluable typing and secretarial support came from Ruth Sheridan, Rebecca Aguilar and Christine Castro of CSULA.

It is not possible here to list all of the individuals, city, county and state agencies, and other contributors to this project, but the research staff deeply appreciates the time and effort required to respond to our inquiries and assist in our efforts.

SECTION I

CONCLUSIONS

The following major conclusions were reached by the project team.

INITIAL INDICES IMPLEMENTABLE

The Initial System of environmental indices developed by the Integrated Regional Environmental Management (IREM) Project in the County of San Diego is being implemented, with some improvements, in Los Angeles. The improvements are made possible by the existing extensive database assembled by the Community Analysis Bureau (CAB) of the City of Los Angeles.

EQI'S WILL AID DECISION MAKING

Inclusion of these indices in the CAB database, which is organized by census tract, is an important means of making environmental data available and relevant in local government policy formulation and decision making.

CAB SCOPE

The scope of the CAB database should be countywide instead of citywide. Virtually all of the environmental data plus much of the demographic data is collected on a countywide basis so that the cost of providing a CAB-type database on a County basis would be little more than it costs to do it on a city basis.

MATRIX ANALYSIS

The statistical techniques, including cluster analysis, that have been used by CAB to analyze an "urban matrix" can be applied to the matrix when expanded to include environmental variables and the entire County of Los Angeles.

ENERGY INDICES

More data on energy usage is needed to develop appropriate indices. The appropriate indices have been defined and the missing data identified on this project.

MANAGEMENT INFORMATION NEEDED

The Initial System of indices developed by the IREM project is necessary but not sufficient for effective environmental management. Further modeling of environmental quality and urban living interactions is needed to identify key variables and effective control indices.

ORGANIZATIONAL PROBLEMS

The primary obstacles to better environmental information and management are organizational. Governmental organizational problems were noted with respect to all six categories of environmental concerns. Air quality seems to have the best coordinated set of organizations but even in this area the split in control responsibility between moving and stationary sources causes suboptimization. The way in which responsibility is assigned for noise, water, land use, solid waste and energy probably only makes sense from the viewpoint of history and tradition. It certainly does not from the viewpoint of dealing effectively with environmental problems. The most crippling condition is the separation of energy from environmental management.

INEFFICIENT DATA COLLECTION

It is probable that a revised environmental data collection system designed to efficiently serve all basic managerial information needs could do so at a net reduction in cost. There is much duplication. The entire data collection system is based on obsolete design concepts that result in inflexible, single purpose filing and report generating systems. A modern system would focus on capturing items once and then tagging and storing them in such a way that they are readily available to a multiplicity of users for purposes not even recognized at the time of data capture. Flexibility and the value of data as a resource should be the keynote of the design.

SECTION II

RECOMMENDATIONS

AMBIENT NOISE PROJECT

Data on ambient noise is inadequate in Los Angeles. This is explained in that part of Section 4 that treats noise index development. Better data could be obtained. A project is proposed in Section 4 to develop initial ambient noise data by census tract as well as a sampling plan to provide continuing ambient noise data input.

ENERGY INDEX PROJECT

The energy use indices defined and investigated on this project should be implemented on a follow up project. The major tasks are defined near the end of Section 4 of this report. Implementation involves establishing energy use standards with respect to efficiency and various side effects as well as identifying, or establishing, data sources. One problem that would seem simple but which proved intractable on this project was finding data on gasoline sales in Los Angeles. For some reason, oil company officials seem to believe this data should be kept secret.

MANAGERIAL INFORMATION PROJECT

The time has come to improve on the Initial System of Environmental Indices developed by the IREM Project in the County of San Diego. This involves moving out along the casue/effect chain from the effects measured by the current Initial System of Environmental Indices. The objective would be to find the critical variables and relationships that determine future environmental conditions. Indices that measure the change needed in these variables would then be devised and implemented. Some initial research done on this is reported in Section 8.

Work along these lines could have three important catalytic effects. It could clarify the need to solve some of the organizational problems mentioned in the previous section, and elsewhere, and perhaps, point the way to improving the organizational arrangements. Secondly, it could improve the effectiveness of the CAB matrix analysis activities. The present techniques being applied are essentially statistical and empirical. The history of science clearly shows that a blend of empirical and conceptual approaches is the most productive. Thirdly, it could spur development of more precise measures of pollution since it would be clarifying the effects of pollution and their specific and basic causes.

TRANSFER TO OTHER CITIES PROJECT

There may be other cities with a group that performs functions similar to the Community Analysis Bureau in Los Angeles (these functions are described in the next section). Or there may be cities, or counties, interested in developing such a group. In either case, this gives an opportunity to contribute to the development of the environmental aspects of a CAB-type database. There is good evidence that this type database can play a vital role in bringing environmental considerations more clearly into urban policy development. Therefore, a search should be made for such opportunities. The distribution of this report to cities is an initial step in this search.

The CSULA and CAB staff that served on this project would be pleased to visit any city whose officials are interested after reading this report. A full exploration of the possibilities and problems could take place on such a visit. The City would then be more likely to make the right decision on how it should proceed with the development of environmental information systems.

SECTION III

INTRODUCTION

IREM BACKGROUND

The research reported herein is the outgrowth of previous work in San Diego County. The findings of that work were applied in Los Angeles. Therefore, it is appropriate to begin by summarizing the San Diego experience.

In April of 1971 the Environmental Development Agency obtained a grant from the Ford Foundation to conduct a two-year project for Integrated Regional Environmental Management (IREM). The purpose of this pioneering project was to help identify and develop solutions for the environmental problems accompanying the increased regional urbanization and population growth of San Diego County.

The importance of basic environmental information was, at the time, recognized nationally by the President's Council on Environmental Quality (CEQ): "One cannot detect environmental changes--desirable or undesirable, natural or man-made--without established base lines and repeated observations. Such measurements are essential for the identification of environmental needs and the establishment of program priorities, as well as for the evaluation of program effectiveness..."[1]

In the spring of 1972 Research Analysis Corporation developed a position paper for the IREM project on the feasibility of developing environmental quality indices useful to the purposes of IREM.[2] This report said that certain indices concerning air pollution, noise, water quality, land use, hazardous substances and housing adequacy could be developed from available data. The report included a review of the state-of-the-art in environmental quality measurement. Basically, it indicated that the state-of-the-art was at the level of measuring environmental status, with some consideration given to measuring environmental change via historical changes in status measurements. The concept of monitoring parameters that determine the future rate of environmental change was not recognized. Nevertheless, this concept was being employed by those concerned with setting automobile exhaust standards for new cars.

The Research Analysis Corporation study recognized that developing measures of environmental status and change is an evolutionary process. The project really only attempted to define and develop an "Initial System" of indices. Only indices that could be implemented in a few months using existing data were included in this Initial System. The criteria used in selecting indices were to be as follows:

> State-of-the-art of monitoring or measuring this aspect of the environment.
>
> The existence of a Standard or other accepted 'tolerable' or maximum level.
>
> Research that had been accomplished leading toward a valid index.
>
> The existence of a source of data or an expectation that a source would be developed to support the index.
>
> A demonstrated need or use of the index, with a favorable cost/benefit ratio (it is estimated to be worth more than it will cost to produce).
>
> The index is integral (or can be made integral) with an overall process of 'Environmental Protection or Control'.

The fact that the fundamental justification for a proposed index was placed next to last in this list of six criteria indicates the short range, action-oriented nature of the IREM index development effort. Calculation of a cost/benefit ratio required quantification of health impairing environmental change possibilities and the empirical data for quantification was (and is) unavailable.

In the autumn of 1972, IREM contracted with California State University, Los Angeles (CSULA) to develop indices as recommended in the Research Analysis Corporation Report, with certain minor modifications. The work was completed in mid-1973. Although it was a conceptually easy assignment, the project team felt that significant progress was made in getting into a realistic perspective the whole problem of measuring an urban environment. The data and time availability constraint caused the project team to separate out the environmental concerns of primary interest to urban dwellers. These tended to be the problems on which at least some data and standards existed. In the end indices (or indicators or simply descriptive data) were developed as follows:

Air indices
Noise indices

Water Quality indices and data
Land Use and Recreation indicators
Solid waste data
Energy data

This represented quite a condensation from the original list of about 50 environmental problems and several hundred possible indices which the original state-of-the-art survey identified.

BASIS FOR THE PROJECT

Problems became evident in the CSULA Project in San Diego in the areas of data sharing and data availability in the place, time and form needed by decision makers. It is one thing to identify data sources, assemble the data in a computer, develop the index values that constitute the initial environmental baseline, and make provision for future comparison of index values with the baseline values. It is quite another matter to integrate the index information into the decision making processes of local and regional government.

The possibility of joining a solution to this latter problem of index usage with the experience in environmental index development led to the Los Angeles project of which this is the final report. The City of Los Angeles established a Community Analysis Bureau (CAB), in 1967, to improve the application of scientific techniques to the problems of City government. CAB had integrated data from many city agencies as well as outside sources into a computerized data base and was making this data, and analyses based on the data, available on a timely basis to the City Council, the Mayor's office and many other city agencies. CAB was interested in expanding the data base to include environmental indices and the CSULA project team that worked on the San Diego IREM assignment was interested in testing the transferability of the index definitions used in San Diego.

This report describes the project of research conducted in 1974 in the City of Los Angeles with the purpose of expanding the scope of analyses within the City's government to include physical environmental measures. For the past seven years, the City via its Community Analysis Bureau (CAB) had been building a database and analysis techniques for describing the "State of the City" in a manner that permits comparisons of alternative use of resources. In the past, depictions of the quality of the social and economic environment had been developed on an SMSA, a census tract, a councilmanic and a total City basis. The purpose of this project was to expand the database so that a picture of the State of the City environmentally could be added to the previous depictions.

During this project the CSULA research staff (which had previously worked on San Diego's IREM project) worked directly with CAB in defining and developing indices of environmental quality, locating data for six environmental variables, assembling appropriate data files, analyzing environmental data, and assisting in the integration of these data and analyses with CAB's existing practices.

As a result of this research, physical environmental measures in six categories described in this report have been added to CAB's analyses capability and will be utilized by CAB in assisting decision making in Los Angeles. An initial action step upon completion of this work will be the incorporation for the first time of environmental data into the State of the City Report in 1975.

For more information on the CAB data files, analysis techniques and State of the City Reports, the reader is referred to the two sections of the report entitled, "Database Development in Los Angeles" and "Data Base Usage in Los Angeles."

INDICES DEVELOPED

The air, noise and water indices developed for San Diego are generally the same as those developed for Los Angeles. These are fully decribed in the next section of this report.

Land use and recreation indicators were not treated as extensively by this Los Angeles project as in the San Diego case. This is because the Community Analysis Bureau of the City of Los Angeles (CAB) already has many land use indicators in their computerized files, and this agency was primarily interested in adding to their files data items on the physical aspects of the environment. The land use information added to CAB files is described in the next section; the existing CAB data items that concern land use are discussed in the section entitled, Database Development in Los Angeles.

The approach to solid waste was the same in both the San Diego and Los Angeles efforts. In both cases information was collected from many sources on the dimensions and important issues involved. The Los Angeles findings are given in the next section.

The approach on energy in San Diego was similar to that of solid waste. In Los Angeles, however, an analysis of energy use objectives was undertaken which led to new definition of energy use indices. These are explained in the following section.

DATA SHARING

This project could almost be defined as a probe of certain dimensions of the problem of overcoming resistance to data sharing. Various agencies of city, county, state and federal government levels expend significant portions of their budgets gathering, editing, filing, sorting, analyzing and reporting data. There is a natural tendency to try to retain control over access to the sets of data collected. Sometimes the data may reveal deficiencies in agency performance. Data that is freely available is available to political opponents.

The resistance to data sharing, however, is not only a matter of human fears and scheming. There are many instances in which different agencies need the same data but they each need it organized in a different manner. For example, CAB requires that all data be organized by census tract.

The organization of data items on a record and the sequencing of records can significantly affect the economic feasibility of obtaining certain types of information. For example, data on air pollution organized by air monitoring stations is not as easily used to provide a councilman with air pollution data for his district as is interpolated data on air pollution organized by census tract. On the other hand, water consumption data organized by census tract would not be ideal for planning future investments in the water supply system.

The Community Analysis Bureau plays an important role in overcoming resistance to data sharing in Los Angeles. The whole purpose of the agency is to make available to city government a comprehensive picture of what the available data indicates is happening in each geographic area of the city. CAB gathers data from the Federal Census, Dun and Bradstreet Business File as well as local agencies, such as police, fire, health, education and assessment files. It organizes all data items by census tract, creates various useful census tract statistics from the raw data and makes all the data available to all agencies that have access to the on-line system at the City's Data Service Bureau. The system is called DATABASE.

On this project possibilities of data links between CAB and many agencies that had, perhaps, not previously interfaced with CAB were explored by the project team. The agencies ranged from the Department of Airports to the County Regional Planning Department to the Los Angeles County Flood Control District to the Air Resources Board to the County's Air Pollution Control District. A complete list of the agencies contacted can be found in the section entitled, Database Development in Los Angeles. As a result of this effort there is more data sharing going on in Los Angeles than before. This does not mean, however, that data redundancy and secrecy no longer exist.

A major need identified by the project was for the CAB to expand to a County-wide data base. Environmental variables do not change at city boundaries. Air pollution, noise, water, solid waste, and energy are the proper concerns of counties and county groups.

Many of the problems encountered in fitting environmental data into the CAB data base derived from the fact that a county agency was responsible for gathering the environmental data and this agency did not have the data organized by city boundaries.

This is not to say that county agencies have the data organized incorrectly. It may well be organized to efficiently support the agencies' activities and responsibilities. The only point is that if the indices of environmental quality and socio-economic data were available by small geographical areas (the CAB approach) both the County Board of Supervisors and the city governments involved could deal with politically sensitive environmental issues more effectively. For example, how much higher is the cost/benefit ratio of a NOX automobile control device for the average resident in South Los Angeles than for the average resident in San Fernando?

Another way in which this project encouraged data sharing concerns two departments in the city of Los Angeles. This project was of direct interest to the City's Department of Environmental Quality (DEQ). In addition to working hand-in-hand with CAB, the CSULA staff coordinated research effort with DEQ by seeking and obtaining valuable assistance in specifying environmental measures and locating sources of data. The research staff, through numerous group and individual meetings, kept DEQ fully informed of progress on the project. A firm commitment of future involvement and working relationships between DEQ and CAB has been made in order to facilitate the development and up-dating of environmental analyses over time. The following quote from a recent letter from the general manager of DEQ substantiates this point:

> "This memorandum is to commend you on your guidance of the project sponsored by the Environmental Protection Agency which has provided the City of Los Angeles with its first complete evaluation of environmental data and data sources available. This information will prove useful to City departments and the City Council in determining environmental impacts and environmental priorities."
>
> "The Department of Environmental Quality intends to take this opportunity provided by California State University at Los Angeles and participate in the continuation of this urban environmental analysis. We also intend to devote our available resources to the continuation of this much

> needed effort; the collection, dissemination and interpretation of environmental information."
>
> "We feel that this data collected on a regular basis and used in the critical urban decisions made by the City Council, will provide the City of Los Angeles with the most advanced environmental monitoring system available to date."

METHOD OF APPROACH

The project work passed through four phases. The first phase was data definition. In this phase the suitability of the indices developed in San Diego for use in Los Angeles was investigated. Data availability was surveyed in a general way and discussions of the nature of the environmental concerns in Los Angeles were held with officials of some of the responsible agencies.

The second phase was data collection. In this phase detailed investigations of the data available from various sources were made. The data, or summaries or samples thereof, were collected. The availability of the data for inclusion in CAB files was explored.

The third phase was data analysis. The nature of the data was studied. Indices were computed. The problems of interpolating or extrapolating the data to individual census tracts were explored. Relationships between energy use and the other environmental factors were studied. Work was undertaken to develop easily understandable presentations of environmental indices and of the concept of using indices to steer environmental policy development and enforcement.

The fourth phase was report preparation. During this phase final arrangements were made with CAB for inclusion of the data and indices in the data base. Each investigator documented the work done on indices in the areas in which he concentrated. This documentation is contained in the next section of this report.

REPORT STRUCTURE

The remaining sections of this report contain the detailed findings and analyses of the project. The following brief description of the content of each section is intended to serve as a guide to the reader interested in either a perspective on the way the report is organized or the location of particular subject material.

Section IV - Index Development

This section covers the anticipated uses of environmental quality indices, the index design methodology, problems of interpolating data to census districts, and specific discussions of indices in each of the six areas: air, noise, water, land use, solid waste, and energy.

Section V - Database Development in Los Angeles

This section discusses the technical reasons for the trend to databases. It describes CAB progress in developing a database and points out the large opportunities that remain for developing improved environmental information systems.

Section VI - Database Usage in Los Angeles

This section discusses the specific uses that CAB and DEQ intend to make of the environmental indices.

Section VII - Future

This section looks at possible further development of the environmental indices in Los Angeles. It then considers the transferability of the index concepts developed on this project to other cities and the appropriate method of approach to effect this transfer.

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2. Macdonald, Donald and Malcolm, Donald G., An Approach to the Development of an Environmental Quality Information System for the San Diego Region. Research Analysis Corporation, McLean, Virginia, May 22, 1972. Whole Book - 135 p.

SECTION IV

INDEX DEVELOPMENT

FUNCTIONS OF ENVIRONMENTAL QUALITY INDICES

An index is intended to point out the meaning of a set of data. The consumer price index, for example, gives the price level today expressed on a percentage of the price level in a base year (1967 at present). Each price level is a weighted average of many prices. The index is a relative measure. It is a measure of the change that has occurred over a period of time.

The idea of an environmental quality index (EQI) is to measure certain changes in environmental quality. To determine which changes should be measured, however, the need for an index must be clarified. The uses concern management of the environment, which really amounts to managing human activities so that they do not adversely influence environmental change. The environmental changes that should be measured, then, are those likely to be influenced by human activities.

The following uses for EQI's and environmental data generally were identified by the project team.

Measure Change

EQI's can be used to determine the impact on the environment of specific programs, which may have been initiated by federal, state, county or city agencies, or by private industry or associations. While it is recognized that many changes may occur in the same time frame, which make it difficult to attribute the percentage of change to different causes, this does not make it less important to know the total change in the environment, from all causes.

Identity Causative Factors

In conjunction with other data that is or will be available, CAB can correlate EQI data to time series of what we might consider causative factors. Attempt to discern the extent to which each of the environmental indices is affected by: 1) higher or lower density land use (e.g., urban sprawl); 2) more extensive public bus service; 3) more, or fewer, regional shopping and business centers, per 10,000 acres of the city land. There are many more "causative" factors that could be tested. The analysis could provide CAB with a more authoritative basis for statements concerning the underlying causes of such urban blight.

Geographical Comparison

EQI's can be used to portray the relative quality of different communities within the city, via the cluster concept. This will remain as important as it has been in the past. The present "E.Q. Status" of the different clusters is one basis for setting priorities, within the city, for special programs. Added to those CAB now produces, would be the E.Q. indices that lend themselves to the cluster type display -- certainly air and noise fit into this category. A "litter Index" would also fit, and so als would a set of land use indicators, e.g. -- open space per 1,000 acres, population per 1,000 acres of just residential land.

Prediction

The ultimate use of the environmental data, correlated with other elements, is the potential ability it gives the city to PREDICT the impact on the environment of each of a series of alternative policy decisions that they might make. These decisions are too numerous and nebulous to catalogue here, but they could include major down-zoning, or up-zoning decisions, restraints on vehicular traffic in conjested areas, e.g., no autos at all on certain downtown streets; where to place new industrial parks. These are land use oriented, but there are many more areas in which the Mayor and Council have an effective vote (or veto). This is one of the more esoteric uses of the data, and remains to be developed. We must be ready to capitalize on good decision making aids when they are developed. We will probably need much more historical data than we have amassed thus far.

Warning Signals

Some of the indicators do not fall into any of the above "use" categories, but are still needed for other purposes. Data on solid waste and water (consumption and pollution) provide an early warning that the city or region is falling behind on public works to cope with changes in the trend line. While these are normally the function of engineering departments, Councilmen do get involved when the money is to be spent, and may need to know more about the interaction of these two variables with the overall environment, or public health of the community.

INDEX DESIGN METHODOLOGY

In developing EQI's, four questions have to be answered:

1. What are the changes that should be measured?
2. What constitutes an accurate quantitative measure of each change of interest?
3. What are the standard relevant mensuration techniques?
4. What is the quality and quantity of the relevant data that is available or economically feasible to collect?

The answers to these four questions will lead to an appropriate index, if there is one. The lack of mensuration techniques on the high cost of collecting the data required to implement an index concept could mean there is no satisfactory index.

What Changes to Measure?

The first question is all too easily answered superficially, and therefore unsatisfactorily. This is simply another version of the common tendency to produce the right answer to the wrong problem. The right index for the noncritical change causes dissapointment in index utilization.

In both accounting and mathematics, it is established doctrine that progressively higher order changes must be recognized in proportions as more dynamic processes are being analyzed. A static business, or constant function, can be satisfactorily characterized by a balance sheet, or measure of absolute value. A steadily growing business, or linear function, can be satisfactorily measured in terms of an income statement, or first order measure of change. An exponentially or erratically developing business, or nonlinear function, requires variable budgets and operating reports, or second and higher order difference measures.

This same doctrine should be applied to answering the first question in index development. What are the goals with respect to an environmental quality, and what changes do we have to monitor in order to be sure of achieving the goals? Are we already at the ideal, and is it simply a matter of seeing that we stay there? Or do we have programs in place that will eventually bring us to the goal? In that case, an index similar to a price level index is sufficient to monitor developments. On the other hand, are we far from the environmental goal, and with no clear hope of ever achieving it? Then we need indices to measure changes in parameters that perhaps cause other parameters to adversely or favorably affect our position with respect to the goal. Of course, in this latter case straightforward measures of status with respect to the goal are also needed -- they are simply not sufficient for management and control purposes.

A major problem in taking this approach to the first question can be a lack of consensus on goals. If we are unsure of our goal, then obviously we are unsure of exactly what information we need to reach the goal. An approach in this case, is to work out the information requirements to measure progress toward each of the goals that has a significant following. This is likely to lead to a larger data processing expense, however.

Quantitative Indices

The design of an index that measures a specific phenomenon is a central problem of statistics. For a full treatment of the subject, the reader is referred to any good statistics text, for example, Applied Multivariable Analysis, by S. Jame Press, (Holt, Rinehard, and Winston, Inc., 1972).

A meaningful index should be stable. That is changes in the index should signal real changes in the phenomenon of interest, and not some random fluctuation. Also, the index should respond to a real change, and not remain the same because of other simultaneous changes. These two properties combined, form the discriminating power of the index.

Indices may be either mathematically simple or complex. Since they are intended to measure change, they may be simple differences or ratios. The percent of land area devoted to recreation facilities is an example of a simple ratio serving as an index. On the other hand, a more complex function may be necessary. For example, a count of the number of days per year that the oxident density exceeds a certain level is a "good" indicator of the smog problem in Los Angeles.

In general, finding a good index can involve much data analysis and experimentation. The final result is often deceptively simple. Much testing has been done in arriving at it, and many alternative indices have been discarded for one reason or another.

Mensuration Technique

An index must be based on measurements. The design of the index, then, has to take into account information concerning measurement practices and possibilities.

The IREM project included an extensive investigation of the state-of-the art in mensuration with respect to physical phenomena. These findings, updated by discussions with technical personnel at the Air Resources Board in Los Angeles, Department of Water and Power and elsewhere, provided a basis for judgements on the reliability and future of various data series.

A closely related factor is the existence of standards. Measurement implies that certain standards have been established. Standards with respect to making a measurement are basic to the integrity of the measurements. The measurement must be reproducible.

Standards that define what is or is not acceptable are also relevant to index design. EPA has established fairly detailed standards with respect to air pollutants and certain other substances. There are many potentially hazardous substances for which standards do not exist as yet.

Data Availability

In addition to technical feasibility, the data requirements of an index must pass the test of economic feasibility. In the IREM project, CSULA staff used as a test of economic feasibility the current (or within six months) availability of the data required to compute the index. The same test was used in the Los Angeles project with certain exceptions.

Data availability is a relative thing. There is never enough data. This project has brought out the inadequacy of the number of air pollution monitoring stations, for example. Lack of sufficient data is overcome by interpolation and extrapolation from existing data. This can be either efficient or misleading depending on how valid the assumptions are on which the inferences are based.

The ultimate test of economic feasibility would be a favorable cost/benefit ratio. The quantification of benefits, however, will usually require that the information cause actions that result in environmental improvements that have some minimum real and quantifiable value to the community. Both the causal link and the quantification of value to the community are difficult steps, as a general rule. In specific cases, however, it is possible to justify an expenditure for data because of the very large benefits that have some probability of being realized.

INTERPOLATION

All environmental categories covered by this project have important spacial dimensions. Many of them also have dynamic characteristics that make the time dimension important. Air pollution varies from one part of the county to another, and from one time period to another. Noise is very local, and has been increasing from decade to decade. Water quality and quantity vary geographically and from year to year. Land use is by definition concerned with space and has a history and future. Solid waste has geographical and dynamic aspects. Energy use information is needed by census tract to evaluate the local and aggregate effects of various proposed policies.

The problem is that data may be collected and identified by one set of spacial coordinates and time units while the user (be it CAB or any other) requires the data by another set of coordinates and time units. The user may need to relate environmental data to demographic data, and to do so, he needs both sets of data organized according to the same spacial and time categories.

This problem is variously referred to in applied mathematics as interpolation, disaggregation, mapping, translation, and so forth. It is not new or peculiar to this project. Nor is it new to CAB. The agency has been faced from its beginning with the necessity to integrated files that have no common geographical breakdown: police files, education files, public health files. At various points in this report, techniques for translating data from one spacial system to another are referred to as "estimation routines", "geocoding", and "computerized interpolation".

No single technique for converting environmental data to a census tract basis has been used on this project. The problem is discussed in each of the following portions of this Section dealing with a specific environmental category. In all cases, there are poor, better, and ideal solutions to the problem. It becomes a question of cost versus accuracy. This is in the nature of a battle line which is continually shifting according to the strength of the opposing goals. Generally, the approach has been to recommend a low cost solution for the initial implementation with the caveat that a better solution be used if greater accuracy is found necessary.

AIR

Rational for Data Collected and Parameters Selected for Use in Study

The work to be accomplished in this part of the study was to establish the manner in which the existing database of the Community Analysis Bureau (CAB) could be extended by the addition of some form of information pertaining to the air quality within the city. To be of most use to the CAB, the new information had to be compatible with that being collected, and had to be available to the city on a routine basis.

Another criteria established for the E.Q. additions to the database was the ability of candidate formats to provide answers to the questions which already have been asked, or are expected to be asked by policy makers and technical specialists within the city administration. The following list is representative of questions that should be answered by the indices of air quality (and in fact, can be answered by an ORAQI or an Episode Day type of index).

1. What is the correlation (if any) between the levels of air pollution, at the census tract level, in the high and low Socio-Economic "Clusters" (groups of census tracts within the city with similar characteristics) that have been developed by the Community Analysis Bureau?

2. In which Councilmanic Districts are the residents exposed to the highest, and to the lowest levels of air pollution, either in terms of the annual avg., the number of days per month, the number of days per "smog season", or the number of days per year in which the federal or state standards were exceeded?

3. Based upon a time series of Air Quality data, which census tracts or "Clusters" of census tracts are experiencing the greatest change in air quality?

4. To what extent do changes in air quality, for a given area of the city, correlate with changes in land use patterns, or other indices of Environmental Quality?

5. What cause and effect relationship can be traced from such analysis of land use patterns?

6. What changes in air quality can be traced back to specific decisions, or broad policies of the City Council, so that this group could, by inquiry, learn more about its own interaction with the environment, through such feed-back?

7. What effect does current energy crisis have on different areas of the city, relative to air quality?

8. How may air and noise data, or correlations between pollution impacted areas and different Socio-Economic Clusters be used to enhance the viability of Federal Grant Applications?

9. What types of state or federal aid to the cities appear to have the greatest potential for improving the worst noise and air quality areas? Mass transportation? Urban renewal? etc.

10. To what extent can demographic changes such as the reduction of inmigration, lateral movements within the city or county, and "flight" from the metropolitan area be correlated with changes in the physical environment, particularly increases in air and noise pollution?

Methodology of Computation of Indices

Interpolation to Census Tract--

The approach used to estimate air quality at census tract locations without monitoring stations was to plot the annual or monthly average of the readings at all 14 of the county monitoring stations and then to scribe a series of arcs from each station, extending one half of the distance to the next closest station. For purposes of this estimate, it is assumed that the air quality varies between any two stations in a set of equal increments, so that a difference of 5 ORAQI index points (or 5 Episode days) between stations A and B, Figure 1, which are five miles apart, can be interpreted to mean that there is an annual air quality gradient between these two stations of 1 index point (or 1 Oxidant Episode Day) per mile. These values are then connected by contour lines, and the area inside each pair of lines is called an "Air Quality Zone". Census tracts that fall 50% or more within a given pair of contour lines are given the ORAQI or Episode Day value found in that zone.

Where a census tract does not fall at least 50% within one Air Quality Zone, it is given an average value based upon the percentage of the tract that falls into the different Air Quality Zones. For instance, if Tract 2103 is cut by contour lines making up three Air Quality Zones, and it is divided equally between them we have assigned the intermediate Air Quality value to that census tract. In other instances, it is simply an average of all the ORAQI values that cut through a tract, based upon the percentage of the area that is in each Air Quality Zone.

Admittedly, this approach must ignore certain anomalies that are due to eddy currents and high ground that might create "islands" of clean or bad air that cannot be explained by their position relative to the monitoring station, but without data for that location, this method of

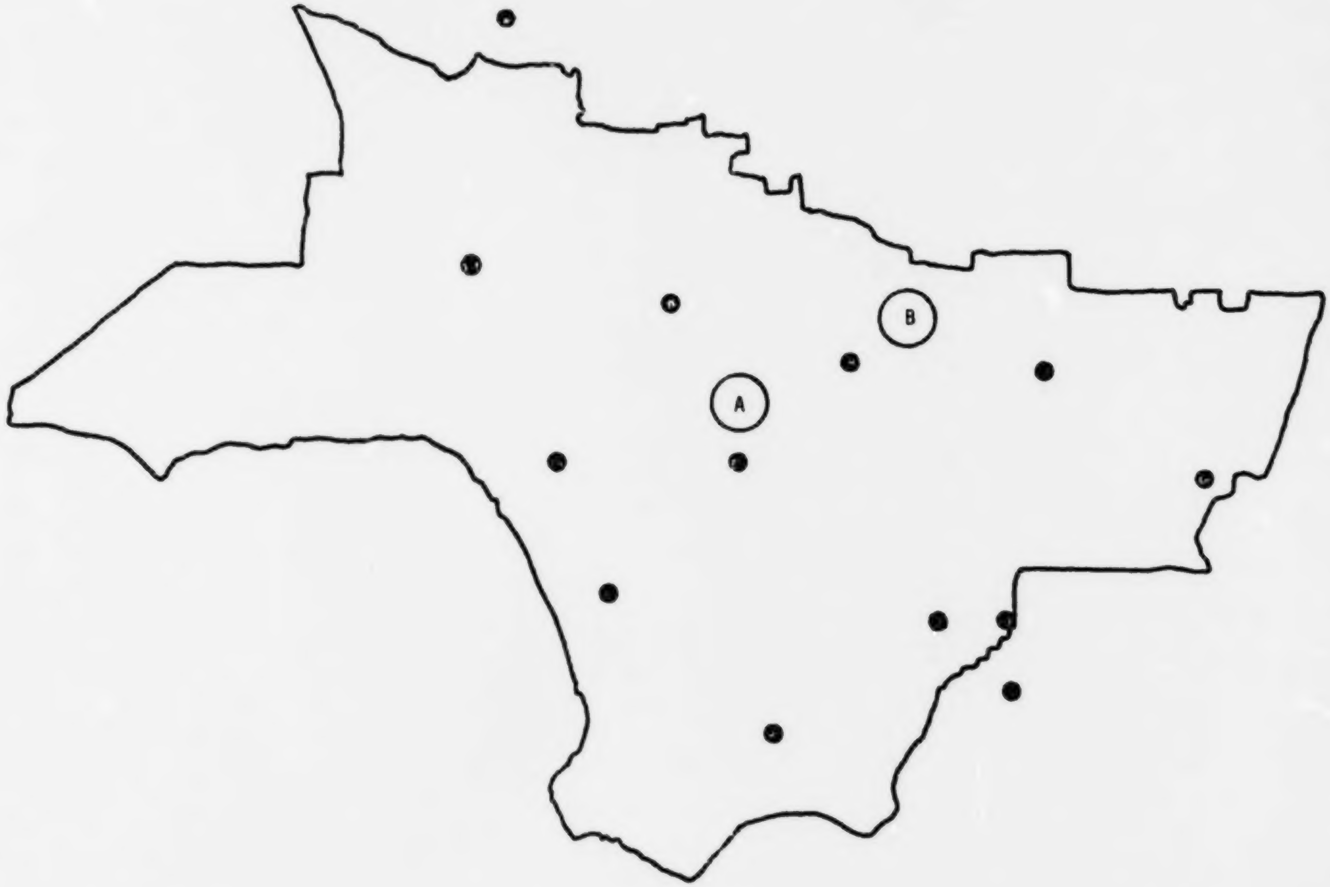


Figure 1. Air Pollution Monitoring Stations

attributing a value to that location is as good as any other.

Computerized Method--

The real disadvantage of the method described is the amount of time and effort required to make a complete plot of one series of data. Investigations revealed that the University of California at San Diego, working under a National Science Foundation grant, had developed a computerized technique for distributing an air quality rating to groups of census tracts, in this instance, to Statistical Areas, of which there are about nineteen in the City of Los Angeles, and a total of thirty-four in the entire county. The technique is explained in more detail in Appendix A.

The computerized solution to the problem has several distinct advantages over the manual method which was used here. The algorithm used to distribute the difference between monitoring stations takes into account the readings at the next closest monitoring station, and could be programmed to make provision for wind current and topological features of the terrain which tend to distort the neat arithmetic used in this study. The automated procedures would utilize data from the surrounding APCD's as well as those in Los Angeles County. A correction factor would also be required to make the Los Angeles oxidant measurements compatible with those used in surrounding counties. Having determined to distribute the air quality measurements across each of the census tracts, it was then necessary to select measures that are susceptible to interpolation from a few monitoring locations to many census tracts. It would not be practical to distribute all 27 APCD air quality parameters to the census tract level because:

1. With that much data it becomes hard to do the interpretation in any subsequent analysis, and
2. A number of parameters are relevant only when combined with others.

Alternative Indices--

A review of the established indices of air quality was made to determine which of these would be most helpful. The most popular of the existing indices are:

Soiling Index, dealing with particulate matter (PM).

Coefficient of Haxe (COH) also an index of particulate matter.

SO_2 Episode Day (number of days per year with .14 ppm for 24 hours).

Sulphur and Oxidant Index - Combines SO_2 and O_x (used in San Francisco and New York City in winter time, to reflect predominant pollutants of that area).

Oxidant Episode Day: Number of days per month or year that the Federal or State Standard is exceeded for 1 hour or more.

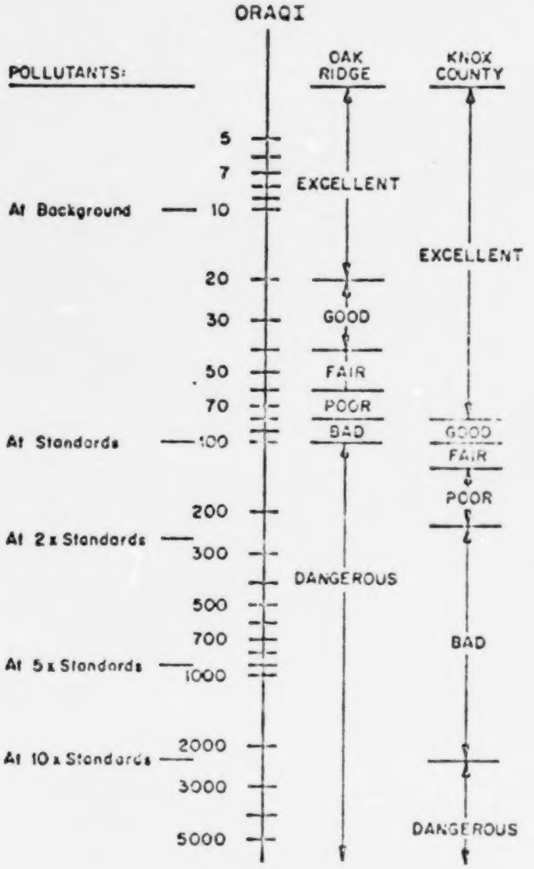
Oak Ridge Air Quality Index (ORAQI).
Which combines all of the above parameters, plus carbon monoxide and nitrogen dioxide, into a single number, about which a set of value judgements have been made as to what index number represent good, fair, poor, bad, or dangerous levels of total pollutants. Figure 2 on the following page, is taken from "Indices of Air Quality", by W. A. Thomas et al, of the Oak Ridge National Laboratory, and the scale marked "Oak Ridge" suggests that index values of 100 or over are indicative of very bad air quality.

From the above list of available indices, the study team selected and computed two indices, the Oxidant Episode Day for 1973 and the ORAQI for 1970. These were for exemplary purposes, since the indexes can be computed for all years from the available data. An Oxidant Episode Day is defined as any day in which the hourly state standard of .10ppm, or the Federal standard of .08 ppm is exceeded. This is the single measure that best depicts the air pollution problem, as it pertains to Los Angeles. The index is the number of such low quality days that each census tract experiences per year.

Oak Ridge Air Quality Index--
The ORAQI value used is the annual average of the hourly readings of the five pollutants that are integrated into this expression. ORAQI weights each of the five in accordance with their known detrimental effects on people,plants and certain materials, such as rubber and paint. It is possible that the average value for the worst four months of the year will provide an even better basis for discriminating between the really bad and the less bad census tracts. Inasmuch as the system installed for CAB will permit this comparison to be made, it is recommended that this be done as part of the analysis of 1974 data.

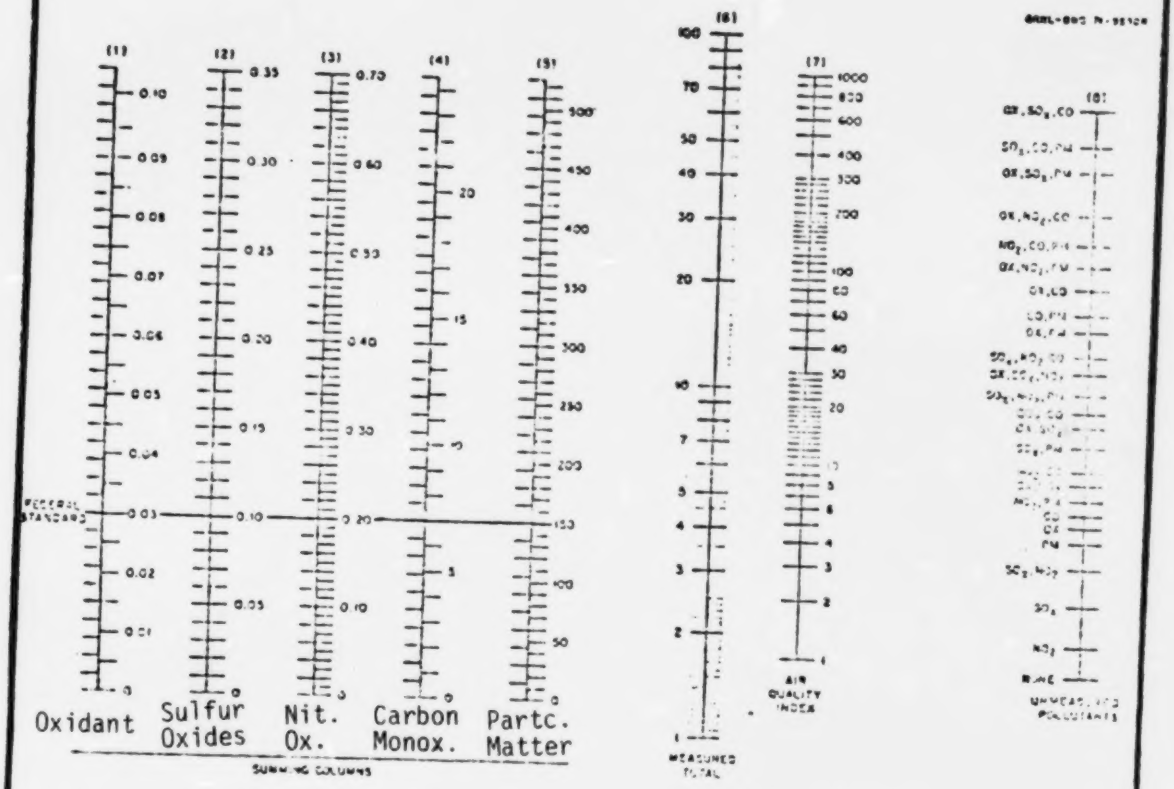
The initial values for ORAQI are obtained by summing the five columns (using the value on the left side of column) in Figure 3. On the right side of each column is a scale of measured values appropriate for each pollutant, and on the left is a scale of index units on which the measurement equal to the federal standard is set to be equal to 10 dividisons, or an index value of 10. In calculating the index, one counts off the number of index units on the left side of the scale which corresponds to the pollutant value on the right side of the scale.

Concentrations from a typical urban area and the corresponding index units from the summing columns are listed below.


ORAQI
POLLUTANTS:
OAK RIDGE
KNOX COUNTY
5
7
At Background
10
20
30
50
70
At Standards
100
200
At 2 x Standards
300
500
700
At 5 x Standards
1000
2000
At 10 x Standards
3000
5000
EXCELLENT
GOOD
FAIR
POOR
BAD
DANGEROUS
EXCELLENT
GOOD
FAIR
POOR
BAD
DANGEROUS

Relationships between ORAQI scale, standards, and local air quality scales.

Figure 2. ORAQI Scales.



Monograph for Determination of Oak Ridge Air Quality Index (ORAQI)

Figure 3. ORAQI Index.

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Pollutant	Concentration	Index Units
Oxidants	0.027 ppm	9
Sulfur oxides	0.05 ppm	5
Nitrogen dioxide	0.04 ppm	2
Carbon monoxide	6.2 ppm	9
Particulate matter	120 ug/m^3	8
	Measured Total =	33

If all of the pollutants were at the federal standard values, the index reading would be equal to 50, which is marginal. An index value of zero would be the unachievable, pristine clear air. A reading of 50 is considered "Fair", with values below that ranging from "Good" (30) to "Excellent" (20 & below). A reading of 70 is "Poor", 90 is "Bad", and over 100 is considered "Dangerous", by the developers of the ORAQI system.

The methodology described by the Oak Ridge National Laboratory, makes a provision for adjusting the index to compensate for pollutants not currently measured, that are planned to be measured in future. Column 8 on Figure 3 is used to estimate an "average" value of missing, or unmeasured pollutants. This procedure is used to avoid the discontinuity or "step function" that would otherwise be introduced into the time series of ORAQI readings when the index was expanded to include pollutants not previously measured.

Much of the work that has been done nationally has indicated that an intermediate value is much simpler to work with than the entire array of pollutants that are monitored by the Air Pollution Control Districts. After a review of applicable schemes for combining the pollutants into a single number, and for the reasons set forth in the preceeding paragraphs, it was decided to utilize both the Oak Ridge Air Quality Index, which integrates all of the pollutants of interest to air quality managers in Los Angeles and the number of Oxidant Episode days per year, a direct index of the single most persistent pollutant.

Data Analysis--

California State University at Los Angeles has also begun work on installing the APCD data base and writing the necessary programs for computation and retrieval of all air quality data on the City of Los Angeles computer.

Arrangements were made to purchase a copy of the entire file of Los Angeles Basin air data from the APCD, and work on a set of programs that would be used to make up two working files from this mass of APCD data. The working files were: 1) by monitoring station, the hourly average of each of the following five pollutants that are used to compute ORAQI:

Total Oxidants (O_x)

Particulate Matter (PM)

Sulfur Oxides (SO_x)

Nitrogen Dioxide (NO_2)

Carbon Monoxide (CO),

and 2) the climatological data that is associated with each monitoring station, but principally:

Wind speed and direction
Ground temperature
Relative humidity.

With these files operative on the City's computer, CSULA proceeded to compute three separate indices of air quality so that it would have some options in attempting to attribute a measure of air quality to either the census tracts or some logical groups of census tracts. The three indices are: 1) Annual average ORAQI (monthly average is also computed); 2) number of days per year in which the hourly ORAQI value of 100, generally considered the threshold of danger, is exceeded; 3) number of days per year in which the hourly average level of total oxidants exceeded .10 ppm (Episode Day Index). The indices were computed for each of the monitoring stations which had complete data (all five pollutants), for the years 1960, 1970, 1971, 1972, and 1973. Monthly indices were also computed for January, February, March, and April of 1974 so that an analysis could be made of the impact on air quality of the reduced consumption of petroleum products during the recent oil "shortage". The 1960 indices are for future use in evaluating such socio-economic data as CAB has for that period with the census data for that year. The 1970-and-on data may be useful in providing hypotheses that are developed as a result of the census tract cluster comparison that are made with data for current and future years.

Presented herein are two of the indices: the 1970 annual average ORAQI (which will correlate with the various socio-economic and demographic data collected in the 1970 census), and the 1973 Oxidant-Episode Days, which utilizes the last complete year of air quality data for a computation of an index value at the census tract level.

Oak Ridge Air Quality Index for Los Angeles County - 1970--
A computer output of the ORAQI annual average for 1970 was plotted on an X-Y grid by the University of California, San Diego, and that plot is presented on the following chart Figure 4 . This same data for 1970 was

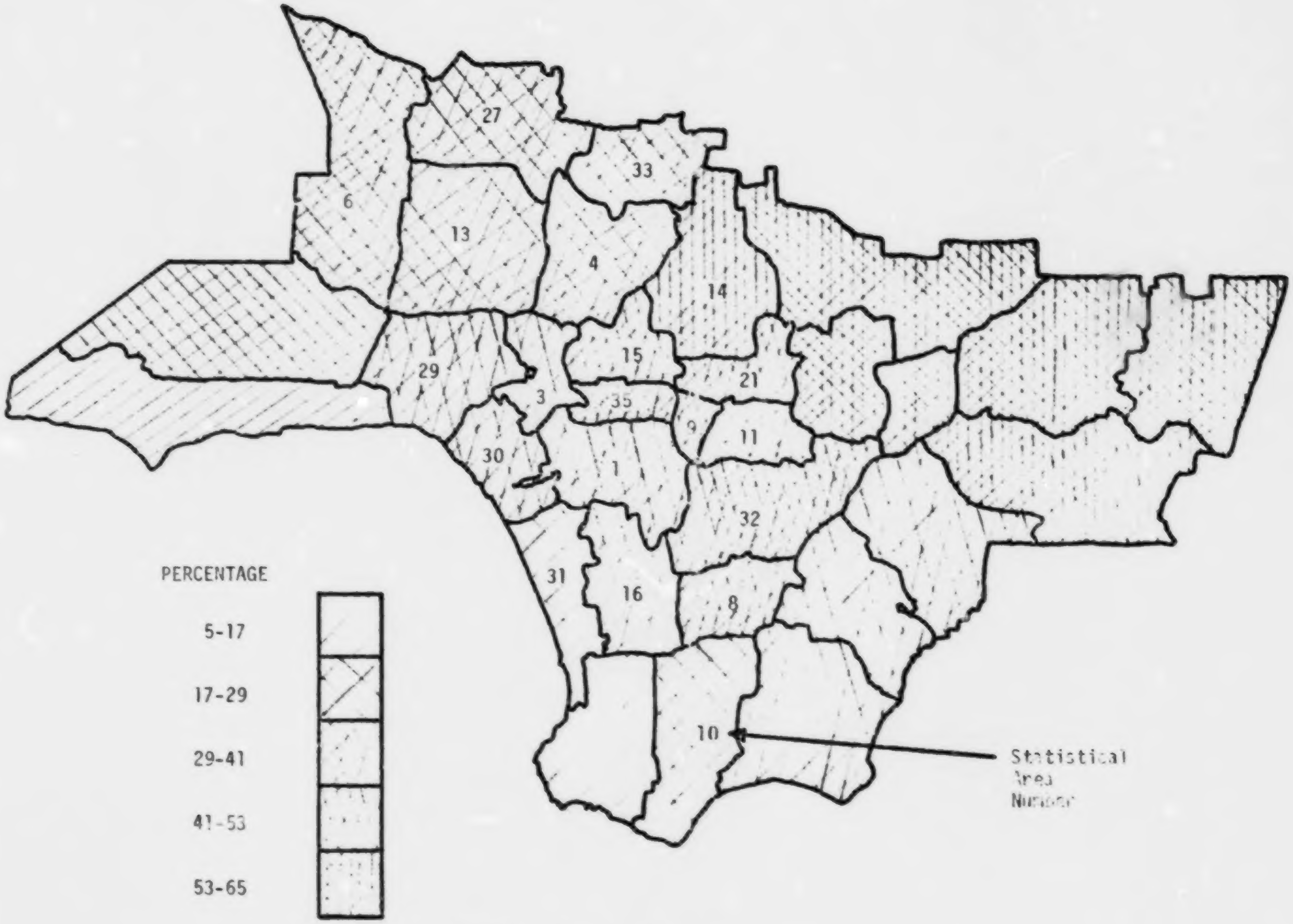
27
33
6
13
4
14
29
15
21
3
35
9
11
30
1
32
PERCENTAGE
31
16
8
5-17
17-29
10
Statistical
Area
Number
29-41
41-53
53-65

Figure 4. Air Quality Index - 1970.

used to compute an average ORAQI value for the centroid of thirty-three of the thirty-five Statistical Areas in the County.

The ORAQI value for such wide areas must of necessity be stated as a range of the ORAQI values, rather than a single number for the entire set of census tracts in the Statistical Area.

From the two-dimensional X-Y plot, and the table (Figure 5), showing the ORAQI range for each area, it can be seen that the inland communities, with the hills at their back and with pollutants being pushed towards them from emitters between them and the shore line, suffer an air quality which, at over 50, is in the "Fair" range, and in the 60's is in the "poor" range, for the entire year. The communities closer to the shore enjoy such relatively clean air, with values between 5 and 29, that according to the ORAQI scale of quality, it is rated excellent and good. A comparison of the 1970 ORAQI values with the Oxidant Day Index for 1973 that follows, shows substantially the same distribution of "good" and "bad" air between inland and coastal communities for both years.

Air Quality Index - Oxidant Episode Days Per Census Tract for 1973

From the Los Angeles APCD tape file of air quality data, a list was compiled of the number of days that the Federal standard of .08 ppm of oxidant was exceeded at 12 stations in the Los Angeles Basin. The number of days per month, with the station number, name of location and the total days per year are shown on the Table of Oxidant days per year, Figure 6 .

This data was then plotted on a topographic map of Los Angeles, with census tracts, at a scale of 1" equals 2000 feet. With the mountains as a backstop, and the prevailing winds plotted, a set of intermediate "Episode Days" was interpolated from the 12 stations, and a set of contour lines fitted to the full set of index points. A value was then assigned to each census tract that reflected the position of that tract in the 'Zones' defined by the contour lines. The contour map is shown on Figure 7 . A chart of the prevailing winds that affect the Los Angeles Basin in July, the peak of the smog season, is shown on Figure 8 .

The Los Angeles APCD value of .08 ppm of O_x was selected, instead of their reading of .10 ppm because recent tests made by the U.S. EPA and the California Air Resources Board indicate that due to a difference in measuring technique, the Los Angeles reading of .08 is actually the equivalent of .11 ppm as measured by the EPA.

The Oxidant Episode Day Index was computed for all of the census tracts. A sample page of this listing is shown in Figure 9 . The index is the number of days that the census tract experienced one hour or more of an Oxidant level of .11 ppm or higher.

Statistical Area #		1970 ORAQI
1	Adams	29 to 41
2	Avalon	Not Computed
3	Beverly Hills	29 to 41
4	Burbank	41 to 53
5	Calabasas	17 to 29
6	Chatsworth	41 to 53
7	Citrus	53 to 65
8	Compton	41 to 53
9	Central Area	41 to 53
10	Dominques/Harbor	17 to 29
11	East Area	41 to 53
12	El Monte	53 to 65
13	Encino/Central Valley	41 to 53
14	Glendale	53 to 65
15	Hollywood	41 to 53
16	Inglewood	20 to 41
17	Long Beach	29 to 41
18	Monrovia	53 to 65
19	Malibu	5 to 17
20	North County	Not Computed
21	No. East Area	41 to 53
22	Norwalk	29 to 41
23	Palos Verdes	5 to 17
24	Pasadena	53 to 65
25	Pomona	53 to 65
26	Puente Hills	41 to 53
27	San Fernando	41 to 53
28	San Gabriel	53 to 65
29	San Vicente	29 to 41
30	Santa Monica/Venice	29 to 41
31	South Bay	17 to 29
32	South East Area	41 to 53
33	Tujunga	41 to 53
34	Whittier	29 to 41
35	Wilshire	41 to 53

Figure 5. Los Angeles County 1970 ORAQI by statistical area.

L.A. APCD Stn. #	Station Name	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	Los Angeles (Downtown)	0	1	1	6	12	20	21	20	18	14	4	0	117
60	Azusa	0	0	1	10	26	24	31	29	28	25	6	0	180
69	Burbank	0	0	1	6	16	23	23	28	24	17	5	0	143
71	W. Los Angeles	0	0	1	5	9	16	16	11	18	10	4	0	90
72	No. Long Beach	0	0	0	0	2	4	2	1	1	2	0	0	12
74	Reseda	0	0	1	9	24	25	31	29	23	13	4	0	159
75	Pomona	0	0	2	10	23	23	30	28	26	18	5	0	165
76	Lennox	0	0	0	0	3	6	1	0	1	4	3	0	18
80	Whittier	0	2	1	7	10	19	6	12	13	16	4	0	90
81	Newhall	0	0	2	10	22	21	31	30	22	10	3	0	151
83	Pasadena	0	1	3	11	20	25	31	29	27	23	6	2	178
84	Lynwood	0	0	0	0	0	0	0	0	0	9	3	0	12

Figure 6. Number of Oxidant Days recorded in 1973, by Monitoring Station.

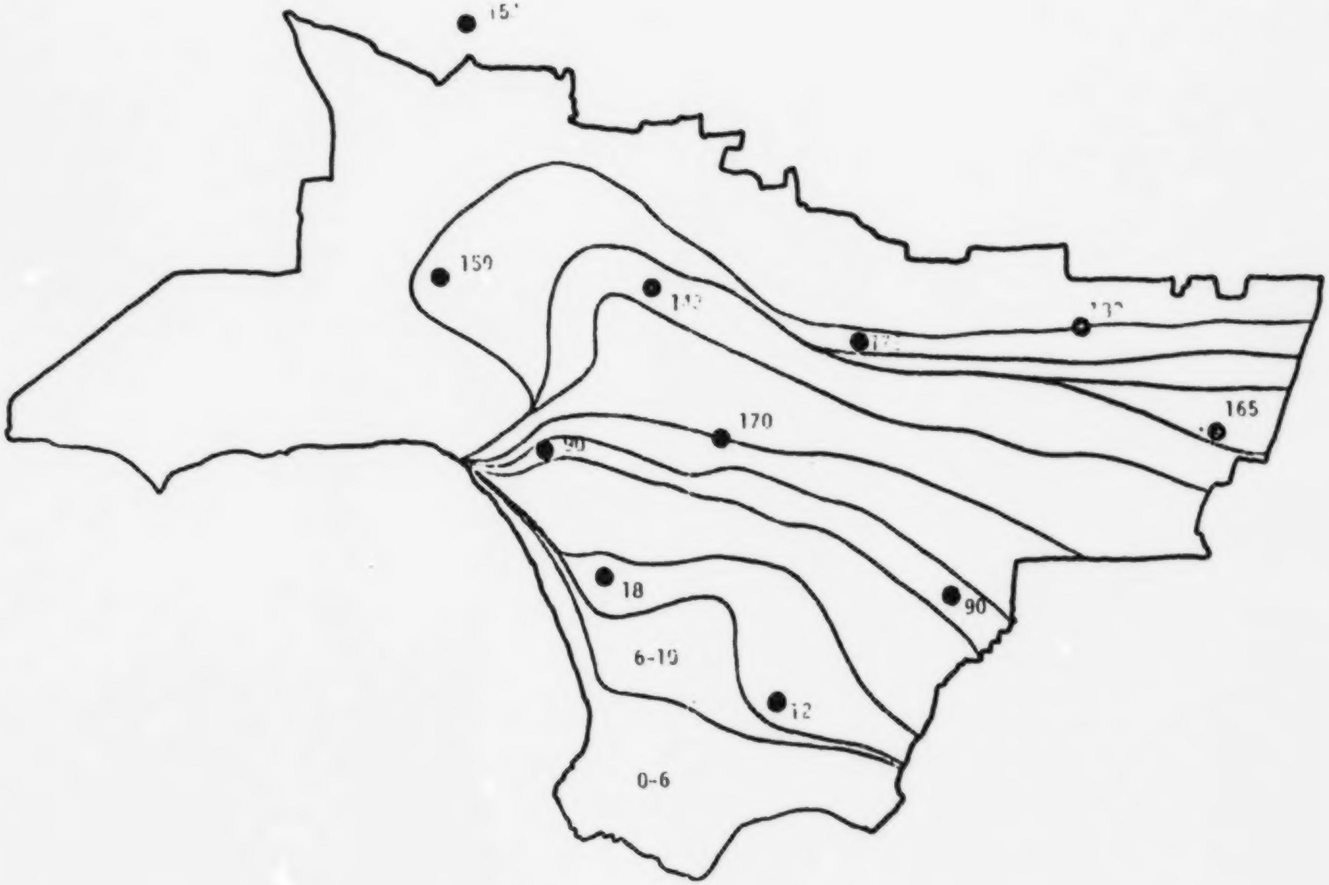
159
170
90
165
18
6-10
90
12
0-6

Figure 7. Air quality contour lines, Oxidant Episode Days, 1973, City of Los Angeles.

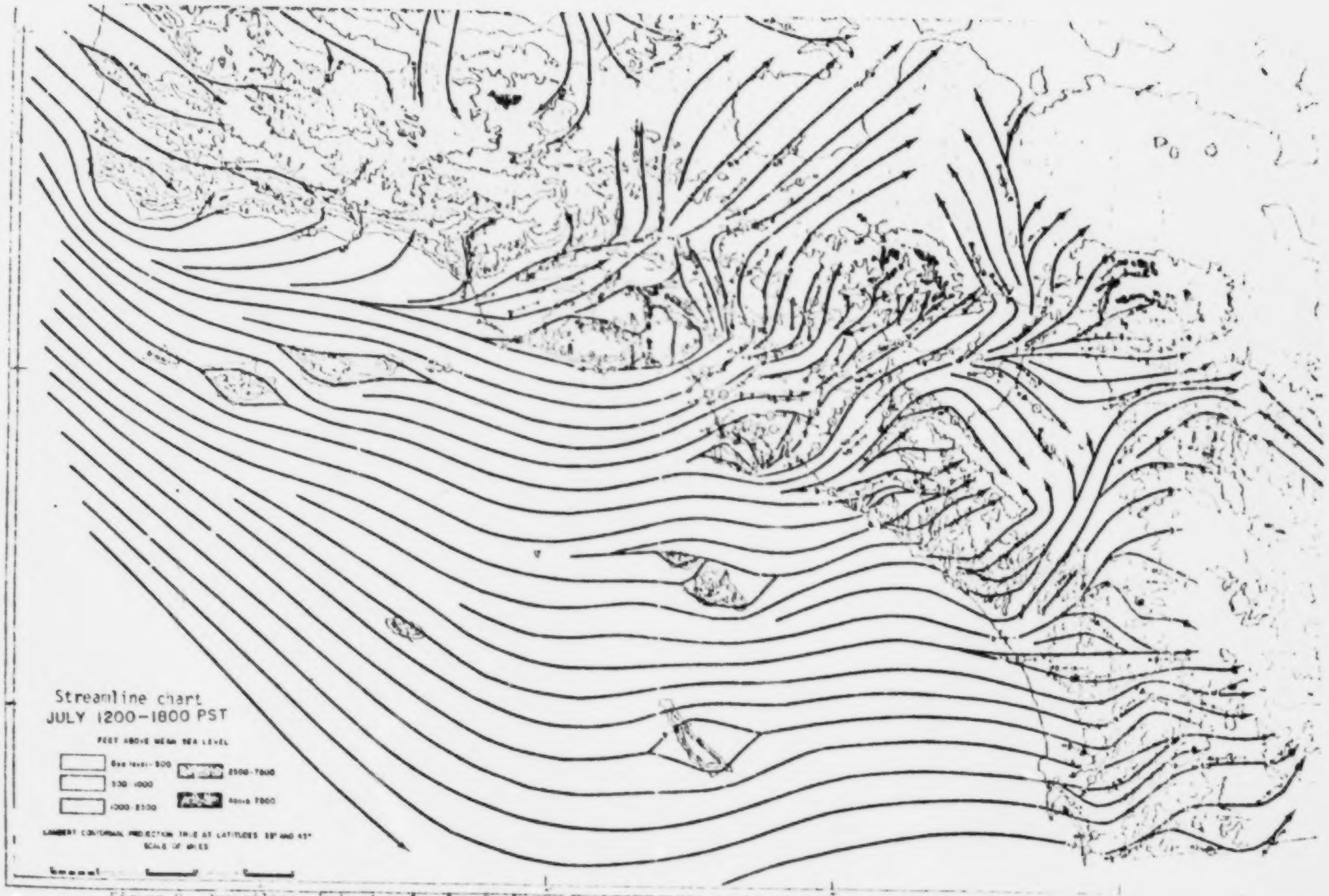
Streamline chart
JULY 1200-1800 PST
FEET ABOVE MEAN SEA LEVEL
Sea level - 500
500-1000
1000-2500
2500-7000
Above 7000
LAMBERT CONFORMAL PROJECTION TRUE AT LATITUDES 33° AND 45°
SCALE OF MILES

Figure 8. Prevailing winds, Los Angeles Basin, at peak of smog season.

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REPORT 2000

STATISTICAL AREA	CENSUS TRACT	OXIDANT DAYS PER YEAR (1973)
Atwater	187100	131
	187200	129
	187300	128
Avalon	228100	80
	228200	77
	228300	79
	228400	80
	228600	74
	228700	70
	228800	70
	228900	63
	229100	63
	229300	68
	229400	60
	228500	93
	229200	90
Baldwin Hills	236100	75
	236300	71
	236400	68
	236201	79
	236202	78
Bel Air	262100	115
	262200	110
Beverly Crest	261101	120
	261102	115
	261200	120
Boyle Heights	203400	121
	203300	123
	203100	122
	203200	119
	203500	120
	203600	118
	203700	117
	203800	116
	203900	108

Figure 9. Example of environmental data by census tract.

By comparing the average monthly or yearly pollution levels (with some type of leveling factor applied to normalize meterological variations), the local governments obtain a very important feedback on the effectiveness of the air pollution control strategies that have been implemented.

Other Aspects of Air Quality that should be Measured

A much better procedure is needed to assess the dispersion of pollutants from the known emitters. Not nearly enough is known about the paths taken and distances traveled by air pollutants, yet into this void we have ventured with approximations of ambient air quality, far from the monitoring stations. The best method of improving current estimates of air quality for all communities is to add monitoring stations and develop better models depicting the transportation and precipitation of airborne pollutants. Also of future value would be data regarding ambient air quality in the immediate vicinity of the worst emitters. This would provide some measure of the hazards people are exposed to before the pollutants have had a chance to mix and disperse to the extent they now do between the point source and the monitoring stations. While it is probably true that the readings at the monitoring stations are representative of the air that the great bulk of the population breathes, more attention should be given to that group of people which lives a short distance down wind of the refineries, power plants, airports, and freeways.

The most obvious solution to problems of collecting additional data is to install more air monitoring stations, but this is an expensive procedure. A compromise might be reached by designing an air pollution transportation model, using data independent of that gathered by the APCD, and then calculating the minimum number of air quality stations that are actually needed. This may require only a few additional stations, but it may also require the relocation of several of the existing stations, so as to improve our ability to interpolate a meaningful air quality value to those communities that are not likely to have an air monitoring station of their own.

With respect to the air quality in the immediate vicinity of the worst emitters, it would appear that mobile monitoring stations, left in a position downwind of a point source, would provide the necessary data. There is some indication that the Los Angeles County Lung Association is going to provide some equipment of this type and make their data available to the APCD. It is likely that CAB could also obtain copies of this data when it becomes available.

NOISE

Rational for Data Collected and Parameters Selected for Use in Study

After making a survey of the data that can be expected to be available to the Los Angeles Community Analysis Bureau on a continuing basis, the study team structured a set of current and proposed future indices of noise that meet the objectives established for these indices in the early part of this study, which are summarized as;

> Provide a basis for the comparison (over time) of the changes in the level of this pollutant, in different sectors of the City.
>
> Provide environmental quality variables with which the Community Analysis Bureau's socio-economic database can be compared, to find correlations (if any) between this set of factors, which collectively define the Quality of Life of residents in different parts of this third largest city in the United States.

Emphasis is placed on the use that can be made of a noise index, in light of the limited power that the city possesses to legislate controls on noise producers. An analysis of the constraints so imposed on the city, is made a part of this report.

A long range objective of the Community Analysis Bureau that is also considered in structuring the noise index is CAB's responsibility to provide answers regarding the current and future effect of policy decisions made at the local level. The following are considered to be representative of the type of question that could have to be answered from the statistical data, socio-economic and environmental, that is gathered and reduced by the Community Analysis Bureau;

1) What is the correlation (if any) between high noise areas and the high and low socio-economic "Cluster" patterns that have been developed by the CAB?

2) What is the annual average change in the ambient noise level in residential areas, business and commercial areas and high noise impact areas (intrusive noise from freeways and airports)?

3) What is the impact, if any, of the combined federal and state noise emission standards now imposed on manufacturers of equipment in terms of: changes in ambient noise in different parts of the city and perceptions of the public, as it may be measured by the number of reported violations of the L.A. Noise Ordinance?

4) What is the correlation between ambient noise level and

changes in the pattern of urbanization, particularly as it is reflected in the changes in population density?

5) What correlation exists between noise and other forms of environmental degradation, in the "Cluster" groups being analysed by the CAB?

6) Which Councilmanic Districts are hardest hit by noise pollution, both in terms of average day and night dB-A, and the number of hours per day that the high levels persist? In which areas of the city is the L.A. Noise Ordinance most often violated?

7) How may noise data, or correlations between pollution impacted areas and different socio-economic CLUSTERS be used to enhance the viability of Federal Grant Applications to improve the quality of life in the worst impacted areas?

8) What types of state or federal aid to the cities appears to have the greatest potential for improving the worst areas? Mass transportation? Urban renewal? etc.

9) To what extent can demographic changes, such as the reduction of in-migration, movements within the city or county, and "flight" from the metropolitan area be correlated with changes in the physical environment, particularly increases in noise pollution?

It is noted that the total noise environment can be subdivided into two types of noise. The first type is the ambient or background noise which is the result of unspecified sources usually located at relatively large distances from the observer. The second type of noise is that which is readily associated with a specific noise source or sources and is generally called intruding noise. That is, it intrudes into the general ambient noise. The ambient noise in a community is an important parameter because people tend to judge the annoyance or intrusion of a new noise by its relationship to the ambient noise.

The ambient noise level is defined as the quasi steady state noise level which exists in an area which is the result of an integration of many unspecified noise sources located at some distance from the area. We use the term "quasi steady state" to imply that the ambient noise level is steady, but does vary slowly. For example, if the ambient noise in a particular area is due to noise radiated from a distant freeway, the noise level at a particular time of day will be steady, but may vary with time of day as the traffic flow rate changes. Of course, if the noise level at a particular location is controlled by an unspecified noise source which is continuously operating and unchanging, then the ambient noise level is truly steady and independent of time of day. In general, the ambient noise level in an area as defined here is controlled by unspecific distance noise sources. The types of noise sources which generally contribute to the ambient noise in a metropolitan area are numerous and can include:

1) surface transportation vehicles, either on city streets or on nearby highways or freeways, including automobiles, trucks, buses, trains and motorcycles;

2) industrial plant equipment, including cooling towers, blast furnaces, large electrical transformers, compressors, etc.;

3) airport related noises, including take off, landing and engine run-up;

4) construction activity (which usually can be confined to the hours of 4:30 a.m. to 4:30 p.m.).

The most notable data deficiency is the lack of 24 hour samples of ambient noise in average residential and non-industrial areas of the city.

The principal source of intrusive noise is the recently completed "Noise Element of The General Plan," produced by the City Engineer's Office. Ambient noise data was supplied by the Department of Building Inspection, partly from a special survey of ambient noise, and partly from pre-construction surveys made in compliance with environmental impact reporting requirements. Together, these sources provide information that support both a city-wide and a census tract level statement of the Los Angeles noise problem.

Available data does not support the development of a comprehensive index of ambient noise for the various communities of the City. Valuable basic research in this subject has been conducted elsewhere and such an index would be of real value to decision makers.

An excellent model for community noise exists in a study done for the City of Inglewood, California in November, 1968 by Paul Veneklasen and Associates and entitled, "Noise Exposure and Control in the City of Inglewood, California", wherein not only airport noise levels were established but measurements were made of ambient noise for the community. This established the background noise level of the city against which to monitor and separate out the high level of aircraft noise in that city.

The Inglewood model cannot be used in Los Angeles since, to the best of our knowledge, no one has ever measured the ambient noise level of the city. Since it seems necessary to establish the level of ambiency before specifying and comparing the contours of high noise from freeways, airports, construction and industrial sites, a section of this report is devoted to an approach to the collection of a much wider sample of census tract, 24 hour noise readings, than are currently available from the Building and Safety Department of the City.

Methodology for Computation of Noise Indices

Figure 10 contains a list of intrusive noises prepared by the EPA. Intrusive noise is generally defined as identifiable noises that penetrate the background of ambient noise level. For example, a motorcycle traveling up a residential street intrudes over the noise levels that are normally present at that location. But ambient noise is really no more than the sum of those intrusive noises that cannot be separately identified. Therefore, most noise emanates from the same sources, whether they are labled intrusive or ambient, and Figure 10 is a fairly comprehensive list of such noise sources.

Intrusively noise sources can be separated into four major categories. The sources in Figure 10 can be identified as:

Transportation noises
Commercial noises (construction and manufacturing, etc.)
Human activity noises (TV and radio, children playing, etc.)
Nongovernable noises (birds, wind, crickets, etc.)

The categories are useful because they facilitate reference to a variety of related data about noise.

The following data is available on these categories:

Transportation Noise--

Transportation is considered the main contributor to an unsatisfactory noise environment. It accounts for over half of the offensive noise levels in Los Angeles. Most governmental effort to improve noise levels is and will be directed at reducing transportation noise. Therefore, most of the effort to measure and describe noise levels should be directed toward transportation sources.

Airports-- Noise impact areas for all of the Los Angeles airports have been measured by Wyle Laboratories in a study for the City Planning Department. Contour maps were drawn which indicate the area around the airports impacted by a noise level of 65 CNEL (Continuous Noise Exposure Level) or more. The contour maps were then overlaid on a census tract map and the square miles and percentage of each census tract that is in

Type of Source	Type of Neighborhood	Maximum Noise Level dB(A)
4-Engine Turbofan Aircraft Landing	Noise Urban Residential	100
Fire Engine Siren	Downtown City	95
Diesel Truck	Freeway Apartment	90
2-Engine Turbofan Aircraft Takeoff	Urban Residential	88
Street Sweeper	Urban Residential	87
Construction Crane	Downtown City	85
Construction Air Wrench	Downtown City	85
Train Passing	Urban City	84
Ready Mix Cement Truck	Downtown City	84
Motorcycle	Urban Residential	84
Rapid Transit Bus	Downtown City	84
Garbage Truck	Urban Residential	83
Freeway Automobile Traffic	Freeway Apartment	80
Automobile Horn	Urban Residential	78
Automobile Sports Car	Normal Suburban	78
Tire Squel	Downtown City	78
4-Engine Turbofan Landing	Urban Residential	74
Automobile on Main Street	Small Town Residential	73
Ice Cream Truck with Music	Urban Residential	70
Private Aircraft Sight-Seeing	Grand Canyon	70
4-Engine Aircraft Overflight	Normal Suburban	70
Car Brake Squeal	Urban Residential	68
Helicopter Overflight	Urban Residential	68
Power Lawnmower	Urban Residential	68
People on Beach	Resort	65
Children Playing	Urban Residential	64
Lawn Edger	Small Town Residential	62
Cat Fight	Urban Residential	60
Dog Barking	Normal Suburban	60
Stationary Train with Engine Idling	Urban Residential	55
Automobile at Distance	Normal Suburban	55
Milk Truck	Normal Suburban	54
Rooster	Farm	54
Radio Playing Music	Urban Residential	52
Crickets in Evening and Night	Quiet Residential	50
Bird	Normal Suburban	45
Children Playing	Normal Suburban	44
Aircraft at High Altitude	Grand Canyon	40

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* Note that these levels are as measured at the various locations and are not indicative of relative source noise.

SOURCE: U.S. Environmental Protection Agency, Community Noise prepared by Wyle Laboratories, December 31, 1971, p. 46.

Figure 10. Example of intruding noises* found in the residential outdoor noise environment.

the impacted area was computed. Figure 11 shows the percentage of each census tract impacted. A comparison of the square miles of area impacted by airport noise in different time periods would be a useful indicator of progress in efforts to reduce airport noise. Correlating this information with changes in population in census tracts impacted by the noise contours may prove useful in establishing the effects of noise on population movement and also provide insights as to the "cause and effect" relationship between environmental degradation and the economic/social indices that have been completed for these same census tracts.

Streets and Freeways-- The State Department of Transportation recently developed an approved methodology which was used by the City Planning Department to produce freeway and State highway noise contour maps that indicate the area around these roadways that is noise-impacted. The ratio of impacted area to total area of the City has been computed as one index of this type of noise. This ratio is 41/465 or 8.8% of the City's land area impacted by freeway noise of 65 dBA, or more. This does not include the paved area itself.

The impacted area is that in which the dBA level is 65 or above according to the noise contour maps produced for the City's general plan. By overlaying a census tract map on the freeway noise contour maps, we were able to estimate the percentage of each census tract that is exposed to the 65 CNEL intrusion. This table of census tracts, with percentages of each that is engulfed by the high noise level, is suitable for direct inclusion in the CAB database, and is provided in Figure 12 of this report. The database already contains the population of each tract, and the application of percentage impacted to total tract population will provide an estimate of the number of persons that are subjected to the high noise levels. This method also provides the number of square miles in the City that are freeway and state highway noise impacted, and the ratio of impacted area to toal square miles in the City as an index of traffice noise pollution.

Freeways and state highways account for only 217 miles of the 6548 miles of roadways in the City, or 3.3%, but in terms of noise generated, they are much more significant. The high-speed travel, the truck traffic and the heavy volume probably make the City's freeways the noisiest element in the life of the Los Angeles population.

Wyle Laboratories recently developed a methodology for the City Planning Department which can be used to produce noise contours for City streets. Presently, no contour maps exist and a calculation of square miles of area impacted by noise from City streets is not possible. It is understood that such maps will be developed. Data on square miles of the City that are impacted by 65 dBA by freeways, airports and City streets, along with information on railroad noise, will provide a comprehensive picture of transportation noise in Los Angeles.

Tract Number	% Impacted	Sq. Miles in Tract
LAX		
2766.01	20	.52
2766.02	90	.77
2766.03	100	4.02
2761	95	.36
2767	100	.52
2773	95	.59
2772	90	.41
2774	80	.88
Burbank		
1243	30	.35
1231.02	50	.65
1232	50	.86
1224	50	.61
1223	40	.49
1221	10	.76
1231.01	70	.30
1222	80	.91
1211	10	3.46
1021.01	5	7.28
1021.02	5	1.56
Van Nuys		
117.02	25	.70
1275	50	2.08
1274	--	.47
1321	5	.48
1276.01	--	.30
1276.02	--	.31
1283.02	5	2.74
Santa Monica		
2731	10	.45
2714	10	.43
2715	5	.36
2713	15	.36
Whitman		
1026	5	.43
1027	10	1.52
1048	5	.82

Figure 11. Airport impact/census tract.

Tract	% Impacted	Sq. Mi.	Tract	% Impacted	Sq. Mi.	Tract	% Impacted	Sq. Mi.
1066.03	10	3.86	1098.01	20	.41	1342.01	10	.56
1065	5	3.13	1096.01	10	.55	1341.02	10	.65
1064	20	1.77	1097	40	.63	1345	30	.74
1061.02	15	.94	1111.02	25	.58	1341.01	15	.41
1061.01	3	2.09	1112.01	60	.68	1316	15	.84
1066.02	10	3.55	1112.03	20	1.46	1315	20	.63
1066.01	10	2.36	1112.04	20	1.38	1314	20	.41
1042.01	50	.40	1131	15	2.17	1313	20	.43
1042.02	50	.59	1132.01	15	2.19	1312	20	.43
1043	15	.83	1133.02	70	1.10	1311	25	.43
1041.02	25	2.20	1133.01	10	.87	1275	20	2.08
1033.02	10	2.63	1132.02	10	3.34	1273	30	.51
1033.01	50	.76	1113.02	50	.84	1277	30	.50
1034	20	1.41	1113.02	50	.33	1176	20	.21
1021.01	5	7.28	1098.02	50	.27	1201.02	35	.23
1014	15	2.61	1172.02	20	.72	1201.01	40	.34
1013	10	.98	1174.02	15	.33	1199	30	.54
1044	10	.86	117.03	25	.34	1198	20	.48
1092	10	.48	1174.01	60	.30	1197	20	.51
1091	15	..61	1175	10	.47	1196	60	.33
1094	75	.69	1132.03	10	2.64	1195	50	.41
1095	15	.37	1344.02	20	1.74	1191	60	.41
1096.02	25	.50	1343.03	20	.61	1214	25	.40
1093	20	.61	1343.01	15	.77	1213	25	.66
1216	40	.42	1374.01	15	.91	1432	60	.38
1217	5	.51	1394	25	1.34	1254	5	.41
1212	10	1.22	1395	15	.66	1431	10	.68
1218	5	.53	1396	10	.96	1436.01	25	.43
1219	10	.65	1391	5	.83	1437	30	1.30
1221	10	.76	1397.01	10	1.20	1897.02	30	.51
1211	5	3.46	1375.03	10	1.31	1897.01	3	3.53
1221	15	.91	1376	10	.59	2672	20	.35
1021.02	10	1.56	1415	3	1.24	2655	3	.39
1283.01	3	.54	1416	10	1.48	2656	5	.39
1283.02	10	2.74	2622	10	3.37	2657	10	.48
1284	3	.68	2623.01	3	4.87	2671	10	.63
1288	5	.57	2623.02	3	1.23	2675.01	30	.17
1289	5	.39	2654.01	15	.28	2675.02	15	.17
1414	20	.43	2654.02	50	.21	1944	35	.41
1413.02	25	.58	2673	60	.28	1922	40	.38
1413.01	20	.39	2677	40	.43	1921	40	.16
1412	20	.55	1434.02	30	.21	1919.02	40	.27
1411	5	.43	1434.01	30	.46	1919.01	50	.30
1287.02	5	.63	1433	30	.61	1923	20	.32
1246	10	.58	1252	40	.50	1918	30	.30
1351.01	20	1.15	1251	5	.49	1901	25	.27
1371.02	10	1.31	1239	25	.63	1902	30	.27
1374.02	10	1.21	1238	25	.61	1896	20	.30

Figure 12. Freeway impacted/census tract.

Tract	% Impacted	Sq. Mi.	Tract	% Impacted	Sq. Mi.	Tract	% Impacted	Sq. Mi.
1375.02	25	.80	1233.01	5	.50	1903.02	100	.10
1375.01	25	.97	1233.02	10	.58	1906	20	.16
1909	20	.37	2082	40	.15	2049	15	.56
1911	10	.25	2081	90	.08	2061	15	.87
1917	20	.37	2074	60	.10	2031	10	.24
1924	50	.38	2072	30	.16	2032	5	.22
1925	50	.24	1977	20	.26	2039	20	.16
1916.01	60	.09	1871	10	.91	1837	15	.98
1915	10	.26	1864	15	.79	1851	5	.83
1926	70	.26	1863	15	1.01	1838	5	.28
1882.01	15	5.67	1861	60	.51	1831.02	15	.50
1881	10	.86	1813	10	.56	2045.02	10	.25
1882.02	15	.69	1812	50	.52	2017	30	.63
1873	75	.67	1811	30	1.09	2016	20	.61
1082	25	.59	1853	10	.46	2015.01	80	.33
1971	25	1.17	1995	15	.38	2011	30	.66
1974	20	.52	1996	60	.21	2092	30	.18
1955	40	.43	1997	50	.35	2093	30	.17
1956	40	.27	2034	40	.48	2096	30	.16
1958	30	.43	2035	60	.37	2097	30	.13
1959	20	.36	2036	20	.29	2242	80	.26
1927	90	.20	2033	5	.44	2244	50	.33
1957	50	.33	2044	10	.24	2241	50	.33
2085	5	.18	2046	5	.25	2263	35	.39
2084	10	.17	2045.01	70	.63	2261	30	.40
2033	10	.27	2065	10	1.61	2245	5	.33
1975	10	.26	2047	40	.38	2246	15	.32
1976	10	.17	2048	40	.42	2311	30	.32
2318	25	.11	2693	10	.83	2768	25	.28
2319	20	.28	2711.02	90	.15	2764	20	.48
2328	30	.23	2711.01	25	.30	2765	25	.43
2217.01	90	.09	2712	40	.41	2767	30	.52
2217.02	30	.12	2678	10	.43	2773	10	.59
2216.01	90	.11	2713	25	.36	2766.03	15	4.02
2216.02	30	.15	2719	10	.54	2781	10	1.74
2215.01	90	.10	2721	10	.46	2774	10	.88
2215.02	25	.16	2737	15	.26	2371	25	.39
2214.01	50	.10	2731	5	.45	2376	40	.30
2188	30	.15	2732	15	.25	2377	30	.36
2187	25	.31	2736	10	.23	2383	30	.41
2186	40	.26	2738	20	.28	2403	5	.32
2185	30	.24	2722	20	.23	2402	25	.35
2184	35	.34	2723.02	20	.20	2405	25	.43
2703	25	.46	2723.01	15	.24	2411	30	.56
2702	100	.21	2741	5	.21	2412	10	.41
2697	5	.34	2754	10	.29	2413	30	.26
2698	20	.18	2753.02	40	.53	2414	50	.40
2701	60	.20	2753.01	20	.76	2415	50	.20
2694	20	.34	2756	40	.31	2416	50	.29
2698.01	25	.18	2751.01	60	.13	2911	20	1.03
2698.02	15	.25	2762	5	.48	2382	20	.37
2718	20	.47	2761	30	.36	2381	20	.38
2717.02	75	.26	2771	20	.47	2397	20	.27
2717.01	10	.33	2769	25	.43	2393	20	.38

Figure 12. (cont.)

Tract	% Impacted	Sq. Mi.
2912	50	.78
2913	60	1.04
2932.01	5	.48
2932.02	5	.41
2933	20	1.15
2944	20	1.25
2943	30	.57
2942	25	.37
2941	20	1.97
2949	5	1.22
2951	10	2.68
2947	15	2.47
2962	20	.95
2961	5	2.10
2965	25	.34
2963	10	.38
2964	15	.82
2967	30	.34
2974	5	.71

Figure 12. (cont.)

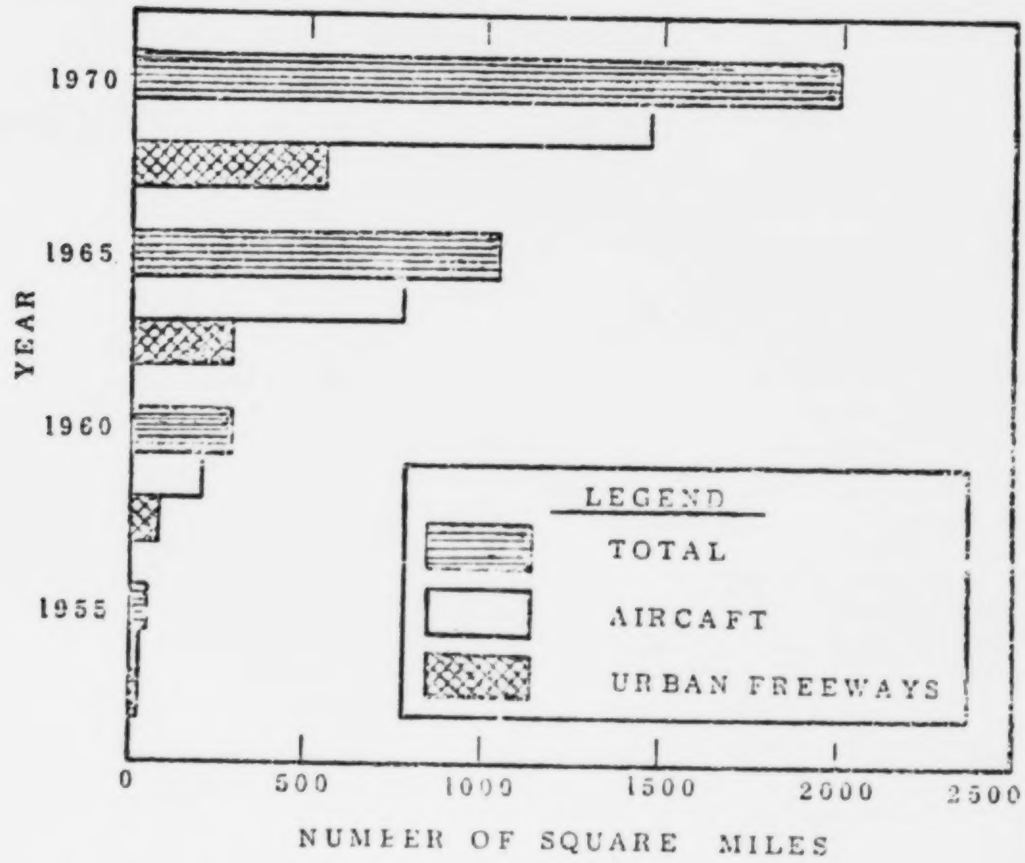
A bar chart, such as the one in Figure 13 prepared for the EPA, could be maintained and would include square miles of area impacted by surface street noise. Another possible method of obtaining an indicator of surface street noise would be from surveys such as the one conducted by the Building and Safety Department. The surveys were made at locations representing a mix of residential and commercial streets of the City. These readings should be rechecked periodically for changes in day and night averages at the various locations.

Railroads-- It has been estimated that operation of a freight or passenger train creates an average sound intensity of 90 dB measured at 100 feet. Another report estimates a level of 65 CNEL at 100 feet for a railroad line with 100 operations per day, although very few rail lines are this active. This report also found the Single Event Noise Exposure Level (SENEL) to be 95 dB. A third report gives a typical CNEL of 65 dB at 215 feet from tract center. Approximately 1040 miles of mainline and branch line tract run through the City of Los Angeles, but in the entire County of Los Angeles only 560 miles of mainline tract and 22 switching yards are utilized by the County's five railroad companies. The number of miles of tract actively used in Los Angeles is not known but could be obtained to establish an index of census tracts affected by railroad noise. With this data, an estimate of square miles of impacted area could be established using the average distances that are impacted by 65 dB from the tract center. For City purposes an index of railroad noise levels should be of secondary importance, since jurisdiction over railroads is severly restricted by Federal preemption.

Helicopters-- Helicopter noise is more a potential rather than a present noise source. But since greater use of this method of transportation is expected, and the City has the jurisdiction to prevent helicopter noise from becoming offensive, the City can be expected to monitor this new source very closely. At present, the only specific information on helicopter noise consists of a statement about the number of these vehicles in use within the City. Short take-off and landing vehicles (STOL) are also included in helicopter information because of the similarity in the use pattern of these types of vehicles. Information on dBA levels in the area impacted by this source would be difficult to obtain and inconclusive because of the lack of regular flight paths. The only index which appears feasible would be the number of registered helicopters. As more helicopters and STOL's are registered, more City effort could be directed toward regulation of noise from this source. The most regulatable aspect of this problem is the control of permits for new helicopters.

Commercial Sources--

Very little quantitative data is available on noise levels that could be



SOURCE: U.S. Environmental Portection Agency, Community Noise, prepared by Wyle Laboratories, December 31, 1971, Page 81.

Figure 13. Approximate growth in aircraft and freeway noise. Impacted land area enclosed by community noise. Equivalent noise level of 65 dB.

attributed to commercial sources. This source would include manufacturing, construction, auto repair shops, auto laundries, etc. As a source of City noise this category would be of secondary importance, but it is still significant and has a potential for becoming an even greater source of annoyance. It should be monitored over time to insure stabilization or improvement in its contribution to the noise environment.

Industrial noise performance standards have been recommended by the City Planning Department and it was recommended that the Building and Safety Department be responsible for enforcement. Should this plan be adopted, industrial noise level data could be obtained from the Building and Safety Department. It is expected that monitoring would be an integral part of enforcement. From data obtained in such an enforcement program, the estimated level of intrusiveness from industrial source could be indexed. Noise internal to the industrial facilities is regulated by State and Federal law, and is not a part of the index contemplated here.

From data obtained by the Building and Safety Department an index could be established which would report noise levels from both construction and manufacturing. Presently the Building and Safety Department is responsible for enforcement of a City-wide noise ordinance regulating fixed equipment in or for buildings on private property. The number of complaints received by the investigation division might also be an indicator of noise from commercial sources.

Construction noise performance should also be monitored. The Building and Safety Department may also have this enforcement responsibility. The Federal Government is regulating the noise emissions of new construction equipment, and the City's building permits regulate the hours during which the equipment may be used, so this source of noise will be more controllable in the future.

Human Activity Sources--
Due to the transitory and intermittent nature of this source of annoyance, probably the best method to index this noise would be by the number of complaints per year that are received by the Police Department. A survey of annoyance levels such as was conducted for the FHA might also be effective.

This source is reported to affect 21.3% of the Los Angeles population and is second only to transportation as a source of excessive noise. Because of its significant impact on the noise environment, monitoring and regulation efforts should be directed towards reducing the level of intrusions from this source.

Noises in this category include children playing, dogs barking, TV, radio or stereo, late night parties, sports or other spectator activities, practicing of musical instruments, lawn mowers, noise from parks and many more. Each of the items is significant, but some are more easily regulated than others. Dog barking is more readily controlled than the noise from children playing, simply because of public attitudes towards these two sources. For this reason, it is suggested that the number of complaints about these types of noise be compiled according to the source of the noise (e.g., dog barking--10c/week, children--5c/week). This separation of sources would give more meaningful information on the effect of regulation efforts.

Index of ambient noise, City-wide--
The definition of ambient noise as used here, for example, means that the noise of a passing truck or bus at a particular location is not part of the ambient noise, although this noise contributes to the noise environment.

The importance of the ambient noise in a community in assessing the probable effect of a new noise which is added to the community cannot be minimized. The attention given to a new noise depends upon its characteristics relative to those of the ambient noise. Thus, discussion of a noise out of context with the ambient noise in which it is heard is as meaningless as a phrase removed from an original speech. For example, an automobile without a muffler would be very noticeable in a quiet suburban neighborhood, but might not be recognized at all at a busy downtown intersection.

In general, the ambient noise levels found in neighborhoods near large metropolitan areas exhibit a spectral characteristic which is low frequency dominated, i.e., most of the sound energy is concentrated at low frequencies with a diminution of sound energy as frequency increases. The reason for this characteristic is twofold. First, the noise sources which contribute to the ambient noise in a large metropolitan area produce noise which contains a relatively large proportion of low frequency sound. Second, the absorption of sound energy as it moves through the atmosphere is greater for high frequencies. The result of this is that a sound which contains high and low frequency energy near the source is transformed to one which contains predominantly low frequency after propagating over a relatively large distance.

In general, the ambient noise level at a particular location will vary with time of day and possibly with day of the week. In addition, it is found that the ambient noise levels depend on the type of area. For example, residential areas usually exhibit lower ambient noise levels than commercial or industrial areas.

From data collected in a 1971 survey, conducted by the Los Angeles Department of Building and Safety, it concluded that the City had an average dBA level of 55.4. Twenty-four hourly readings were taken at various locations that representa cross-section of the Los Angeles area. The readings for each location were averaged and the site averages obtained were again combined. The result was the City-wide average dBA level. For use in making future comparisons, it was concluded that this average would be more significant when stated as the day average and the night average. These calculations were easily made using data from the above survey. The result was a day average of 57.6 and a night average of 49.3. The Ldn (wherein the night time readings are weighted per the EPA recommended procedure) was also computed for each location and is presented in Figure 14. The Alvarado section, with an Ldn of 71.7 dBA, is significantly more noisy than the quietest, (Glade Avenue) with an Ldn of only 50.2 dBA.

The very small number of census tracts (10 out of 720) that are represented in this survey, makes it almost impossible to produce a general statement about ambient noise in the City. These data will provide an important bench mark with which to compare, say in 1977 and in 1980, the overall impact of federal, state and local efforts to reduce noise by the various legislative devices that are currently being enforced.

What the Indices Mean

The indices presented in the preceeding section provide a one-time bench mark of the major sources of intrusive noise, and a small sample of the present level of ambient noise for the City of Los Angeles. These indices are valuable only for comparison of these same conditions, in this City, in some future time frame. Such comparison will indicate either an improvement, further deterioration of the environment, or perhaps no change at all. Assuming that some changes will be detected, a series of such comparisons will provide an indication of the rate of change. A comparison of these changes, when analysed against the set of environmental decisons that were made by the City Managers during that period, will provide the 'feed-back' that could lead to better decisions in the future. The bench marks that are provided here include the following:

Square miles impacted with 65 CNEL or more by airports.

Square miles impacted with 65 dBA or more by freeways and state highways.

Square miles impacted with 65 dBA or more by major surface streets (when completed).

Ambient noise levels in dBA, (night and day average), for various locations on the city, Lda for these locations and the average

Location	Ldn*	Census Tract	Cluster
1. Glade Avenue	50.2	1132.02	3
2. Londelius Ave.	51.6	1173.03	4
3. Weidner	53.6	1042.02	3
4. Riverwood	54.2	1032.01	3
5. Terryview	52.1	1438.01	6
6. Alvarado	71.7	2088 & 2089	28
7. Tremaine	56.9	2161	19
8. Euclid & Whittier	68.1	2047 & 2048	30
9. Euclid & 8th St.	67.5	2047 & 2048	30

City Ldn average=58.44

*Using formula from EPA report on Environmental Noise Levels as of March 1974 (p. A-22)

Figure 14.

Ldn for city.

These measurements also provide for computation of the numbers of people that are affected by the various intrusive noises, by census tract and 'cluster' of tracts so that the correlations described at the beginning of this section can be made by the Community Analysis Bureau for future 'State of the City' reports.

The Environmental Protection Agency has developed typical ambient noise levels for various city regions. This information should be consulted to compare Los Angeles noise levels with the rest of the country.

Legal constraints--
Emphasis is placed on the use that can be made of a noise index, in light of the limited power that the City possesses to legislate controls on noise producers, and this section of the report contains an analysis of the constraints imposed on the City in limiting noise pollution.

The utility of some of the possible noise indices for use at the local level are conditioned by the City's lack of jurisdiction over noise sources. The limitations affect a city's ability to change noise levels through ordinances and this should be considered when determining the relative importance of an index.

Generally local authorities have all jurisdictional powers not pre-empted by the State or Federal government. This makes it necessary to describe local jurisdiction by what it cannot do, rather than be describing what it can.

For this purpose a simple list of actions a city cannot take is shown here:

	Action	Pre-empted by
1.	Prescribed noise standards for manufacturers of new products.	Federal Law NCA 1972
2.	Prescribed noise standards for vehicles engaged in interstate commerce	I.C.C.
3.	Prescribed noise standards for vehicles registered in the State (on or off highway)	State Law Sec. 23230, 23230.5 & 38280 of Motor Vehicle Code

	Action	Pre-empted by
4.	Prescribe noise standards for motor boats used in inland waterways	State Law Sec. 654.05 of Harbor and Navigation Code
5.	Prescribe industrial noise standards set out in 5096 Administration Code	State Law Sec. 5095 et seq Administration Code

The City is jurisdictionally restricted mainly in the area of aircraft and motor vehicle noise emissions. The City does, however, have the authority to enforce state-set standards for on-and-off highway vehicles. The City also has the representation in state government to effect desirable standards. Airport noise is controllable through land use planning, possibly curfew laws for city-owned airports, and regulation of noise from private planes flying over the City. Even noise from vehicles operating in interstate commerce can be regulated by routing them through the City on streets selected for their remoteness from residential sections.

Conclusions

Meaningful data on the Los Angeles noise environment is presently very limited. Specific noise data on freeways and airports has been developed in some detail and it is expected that monitoring of these sources will continue. But there appears to be very little information on the overall Los Angeles ambient noise environment.

Three new methods of collecting this information should be considered.

Ambient noise surveys for selected city location.

Survey of community annoyance levels.

Utilization of Environmental Impact Reports produced by City and State departments, which often include a measure of pre-construction ambient noise.

If the City-wide ambient noise average drops over time and this information can be correlated with an improvement in community attitudes towards the noise environment, there is some assurance that city efforts have been fruitful and should continue. The information obtained can be broken down into ambient levels for certain areas, (such as by census tracts or "clusters"), and compared with attitudes in these areas. This information could be compared with information obtained by overlays of noise contour maps to find any correlations that exist between improvements in airport or roadway noise contours and improvements in the ambient level and attitudes. Many correlations are possible once the data is obtained.

Collection of the recommended data is naturally restrained by the resources available for noise monitoring. But the task could be accomplished by a student work force with a very limited amount of instruction on the use of a simple sound level monitoring instrument, with an "A" scale, survey questionnaires could also be administered by the same student work force making the compilation of basic data.

The following procedure is recommended for development of additional noise data, suitable for use in the CAB database:

a) Make ambient noise surveys of selected sections of the City. It is suggested that a wide sample of the census tracts be taken, to include perhaps 7% or 8% of all tracts in the City, and that these be selected in such a manner that the 60 or 65 census tracts provide a profile of the census tract "clusters". This would be stratified, rather than a random sample, and would coincide with the locations in which the "Attitude Survey" would be made.

The samples would consist of one full day (24 hour periods) taken mid-week, between noon Tuesday and noon Friday. Each location would have 24 readings of 2 to 4 minutes each. The students would be trained in observing the low and high points reached on the meter during each of the 2-4 minute periods, and instructed to ignore the "spikes" caused by a passing motorcycle, or other intrusion.

A group of students at the California State University, Los Angeles, would be selected with the cross section assessed by their addressess, so that the students could take the required readings in the vicinity of their homes.

Ten (10) Sound Level Meters (SLM) rented for a period of two or three weeks, would be adequate to collect the requisite number of samples. The hourly readings will permit computation on the Ldn, which weighted measure, when these are averaged for all locations, will provide an index for the City that can be compared with other cities in the nation that are adopting the EDA sponsored Ldn the standard measure, or index of community noise.

This survey would establish a firm base-line for many future analysis of the impact on different types of census tracts, of the combined Federal, State and local efforts to abate noise, over the next five to ten years. This sample appears adequate to permit a useful correlation of noise with the socio-economic profile of the "clusters", and they may also provide some insights to the question of why families move from one address to another.

b) An attitude survey, conducted in the immediate vicinity of the locations for which Sound Level measurements were taken, will provide a very useful indication of how the general population, and also how residents of particular sections of the City, perceive their own environment.

The survey instrument can be easily adopted from the format developed by the U.S. Department of Housing and Urban Development for use in a recent national survey of attitudes towards noise. This survey may be more useful because of the ease with which the householders attitudes towards noise can be correlated with the actual noise index (Ldn) which will be available for those sections in which the attitude survey is to be conducted.

The survey instrument is simple enough to administer that we can be assured of good results from CSULA students, given a minimum indoctrination in both the scientific aspects of noise and in basic interviewing techniques. A sample of 500 respondees, drawn about equally from the 60 census tracts in the noise measurement sample will provide eight responses per census tract. This should be adequate for the purposes described above.

After a suitable indoctrination, the students would take a series of 3-5 minute noise level (A-weighted) samples, one each hour, for a 24 hour period at each selected location (which will be in the vicinity of the students place of residence).

Following the samples of actual noise, the students will interview (and administer the attitude survey) to a small sample (about 8 persons) at each of the locations selected for the ambient noise measurements.

The third recommendation is that CAB have itself put on the distribution list for the Environmental Impact Reports produced by the California State Department of Transportation Department and the Los Angeles Building Safety Department. The EIR's for public projects often contain week long series of 24 hour samples of ambient noise, and these, when coded to the appropriate census tracts, and dated , will enhance the data that can be collected by the student project, and provide the measure of change, over time, that is now lacking.

WATER

Introduction

During this EPA sponsored research project work was completed toward the development of indicators of water quality. These indicators were developed for the Los Angeles water basin and were intended for use as a means of determining the physical condition of water in the basin or water imported to the basin and the changes in those conditions over time. In turn, these indicators were intended to be used as the basis for governmental action to maintain present water quality or to imporve upon it. While the research focused upon Los Angeles County, the indicators resulting from this work reflect physical changes which are characteristic of water systems virtually anywhere in the United States. This means that the indicators reflect changes in quality of water that resides in the ground, on the surface of the ground, and in larger small bodies of water. In the case of Los Angeles County, the larger bodies of water include the ocean as well as internal lakes systems.

Data Collection

The rational for data collected during this research project was that it be used to produce indicators whose changing values would reflect changes in condition of water available in the local area. As a means of focusing this data collection process, the water available within the Los Angeles County basin was conceived of as a part of a closed and highly interrelated system. This system involves ground water, surface waters, and ocean waters. In this system a very large but inprecisely defined volume of water is subject to change by various influencing mechanisms.

These mechanisms include pumping water from the water table in the ground, precipitation in the form of rain and snow, evaporation of water from the surface, reclamation and reuse of used water, and importation of water. The quality and quantity of this water and the way in which it changed as well as the operation of the influencing mechanisms is the area of responsibility for the large number of water agencies in the region. These agencies include private water companies, agencies of county government, agencies of the state government, private individuals, agencies of the federal government, and agencies of the cities in the region. Consequently, the focus of data collection for this project was upon those agencies whose data reflect changes in condition of water in the basin. The various agencies contacted are listed below:

Los Angeles County Flood Control District
Los Angeles Regional Water Quality Control Board
Private Industry (1400 light to heavy industries)
Southern California Coastal Water Research Project
The Sanitation Districts of Los Angeles County

The Southern California Metropolitan Water District
Los Angeles Department of Water and Power
Central and West Basin Water Replenishment District
Sea Grant Project
U.S. Environmental Protection Agency
Other Federal Agencies such as Weather Bureau, U.S. Coast and
 Geodetic Survey, and the Department of Interior
State of California Department of Health
Private and Public Water Companies
City Departments of Public Works
California State Department of Water Resources

Agencies in the region involved with ground water attempt to maintain data on the quality and quantity of this water by the use of indicator wells. Samples are regularly taken from these wells to determine the level of the water table beneath the well and to determine chemical and biological characteristics of the water through chemical analysis. There are some 8,000 wells in this particular region which are part of the overall program for collecting data regarding quality and quantity of ground water. In the process of collecting data from these indicator wells, information is obtained regarding the PH of the water, temperature, water level, total dissolved solids, biological oxygen demand, turbidity, nitrate concentrations, phosphate concentrations, chromium concentrations, radioactivity, electrical conductance, etc.

The surface water for this coastal region is measured periodically in order to determine the volume of surface water either stored or running off through natural or man-made channels. Such channels in this particular area include the San Gabriel River, the Los Angeles River, Dominguez Channel, Ballona Creek, Topanga Creek, and Malibu Creek. These channels represent the confluence of a system of washes, streams, and rivers which drain from the mountains to the plain and empty generally into the ocean. In addition to these channels, surface water quality and quantity are also measured at the five reservoirs within the coastal area. During this data collection program for surface water, information is collected that describes many of the same variables that are obtained in the ground water data collection effort. These variables include such things as PH, turbidity, BOD, etc.

Ocean water involved in tne water quality programs of coastal Los Angeles are those that lie immediately off the coast bounding the Ventura County line and San Pedro Bay, and within the major bays and harbors along the coast. These include San Pedro Bay, Los Angeles Harbor, Redondo Beach Harbor, Santa Monica Harbor, and Paradise Cove. Major concerns in ocean water quality monitoring programs are the off shore oil wells, the sewer outfalls along the coast, and the runoff occurring naturally through the river and stream system which drains into the ocean. The data collected concerning water quality of ocean waters contains the same set of variables as that collected for the surface and ground waters in the region.

Data was collected from the many water agencies in the coastal Los Angeles area that are responsible for monitoring and operating water programs, for conducting analysis for water planning, and for evaluating the awesome volume of data which has been collected over many years to describe the quality and quantity of water available within the region, or available to the region from outside sources. While the data is generally collected by the agency for its own internal purposes and to support the legislative responsibility given to it, there is also some general move toward developing a cooperative program of data collection. This cooperative data collection program is, of course, very desirable because the subject, the quality and quantity of water that was in the region, is the same in all cases. It is characteristic of most water systems in the United States that there is a similar set of agencies involved in collection of data concerning water, and in many cases these agencies are involved in similar cooperative programs.

To support this data collection effort, the approximately 1,500 public and private water agencies have established data collection programs that involve literally thousands of people and thousands of stations from which samples are regularly taken. In most cases samples that are taken are recorded on manually prepared forms. In some cases, these forms are keypunched for storage and retrieval using computers. The use of computers to maintain this large volume of data is receiving more and more attention both in the Southern California region and in other water systems throughout the United States. The availability of computer readable data, of course, also greatly improves the efficiency with which analysis can be conducted in the development of indicators.

Data Analysis

There are two general approaches that can be used in the development of indicators of water quality. The first of these entails a detailed analysis which results in the development of statistical aggregates. These statistical aggregates in turn reflect the systemic changes in characteristics of water based upon the systems interactions that exist between various components of the water system. The development of statistical aggregates as indicators of water quality and quantity imply a very extensive understanding of the physical interaction and functioning of the local water system.

This extensive knowledge of water systems interactions is at the state of the art for most local governments. Nonetheless, statistical aggregates, just as economic indicators, possess a great deal of value as means of measuring overall system performance. The second approach is the simplier of the two. This approach involves collection of data from various sources and use of the data on an individual basis to portray changes in value over time. Using this approach, a picture must be developed on a series of graphs of change of values over time which together portray the operation of the water system. However, using this approach the individual changes in data can also be used in monitoring the more detailed aspects of individual programs in connection with water. The second approach is the one which itself would be most useful in a practical sense to the local governments involved in this research project and could also form the basis for similar other works in other water systems throughout the United States.

The indicators selected as a result of this analysis are those which reflect changes in the quality and quantity of water available for use within the Los Angeles coastal area. Specific water quality indicators selected are coliform counts, trace constituents, total dissolved solids, nitrates, and chlorides. These five indicators cover the various dimensions of water quality ranging from potability measured for example using TDS and NO4 to changing land use characteristics measured for example with coliform counts, the presence of chlorides, and the presence of nitrates. Water quantity indicators chosen include the amount of evaporation, precipitation, importation, pumping, replenishment, and reclamation. These indicators cover all of the dynamic mechanisms which contribute to the changing net quantity of water available for use within the county. These indicators being the simplest in nature are those possessing the longest history of collection. In this study, data was conveniently available, often in computer readable form, from the year 1900 to 1974.

The computations completed in connection with the data collected involve simply portraying the trends in the value of variables such as TDS over time and by comparison with standards set for those variables. In many cases, of course, data is missing from the historical records, or some data has not been collected for specific geographical areas in the Los Angeles region. In those cases, trends were interpollated between adjacent points in time and displayed as dots on graphs. Another aspect to the computation in connection with display of water quality and quantity indicators is related to the geographical units of reference. Much of the analysis conducted by local governments which forms a basis for program decisions is currently referenced to the census tract. That same unit of reference is used by most local governments in the Southern California region as well. However, in connection with water which is ubiquitous phenomena and which is part of a very complex and highly interrelated physical system the use of the census tract will be arbitrary at best. Most of the agencies from whom data was collected have collected the information in terms of geographical units which reflect the realities of physical characteristics of the water system. For example, the Department of Water Resources uses hydrological subareas as the basis for reference. Consequently, the data that was collected was portrayed not only in terms of time and in terms of levels of the value of variables, but also in terms of the geographical units which reflect characteristics of the water system for the area. A diagrammatic view of the Los Angeles basin water system and a diagrammatic but typical geographical unit of reference is shown in Figure 15. This diagrammatic view of a cross section for the region also shows the interacting forces in the system for which water quality and quantity indicators were produced.

Meaning of Indicators

Total Dissolved Solids--

Total dissolved solids is a measure of total mineralization of water. In general, the higher the total dissolved solids, the less desirable the given water supply is for beneficial uses, although this also depends on the particular constituents making up the total dissolved solids. Electrical conductivity is a measure of the ability to pass an electrical current and is roughly proportional to the total dissolved solids. In much of the data used, the electrical conductivity is collected by agencies and can be easily converted to total dissolved solids or TDS. In simple terms, TDS refers to the desirability of using water for human consumption.

The data collected for total dissolved solids is portrayed in Figures 16 & 17. The method of portraying this data is characteristic of all of the data that is collected in connection with water quality and quantity for the region. The graph shows the geographical areas which are major components of the region water system and the concentrations of TDS are plotted for these geographical areas. All of the data values plotted cover the historical period from 1900 to 1974. The graph in Figures 16 & 17 also shows how the concentrations of TDS for various geographical areas compares with ground water standards set by local agencies and with standards set by federal agencies. The interpretation which can be placed upon Figure 16, which involves essentially a mountainous rural area is that the water obtained from wells in the area generally contains a very high TDS concentration, above both the local and federal agencies standards, and therefore, consists of water which would generally not be as desirable for human consumption as water which contains TDS concentrations falling below the standard shown. By comparison, the data portrayed in the graph in Figure 17 shows the concentrations for TDS in the Los Angeles County area which is not in the mountainous area, that is the Los Angeles basin area. Water quality in this area falls well within standards set by federal and local agencies for most geographical subareas. In three conspicuous geographical subareas, i.e., 4.A1, 4.A2, and 4.A4, the local ground water standard is exceeded. These particular subareas are immediately adjacent to the ocean. As ground waters are depleted in areas adjacent to the ocean, the incursion of salt water into the fresh water aquafers would tend to increase the concentration of TDS. This accounts for the high concentrations in the three areas just noted. One other item in connection with the Figures 16 and 17 is that the concentrations are displayed as average of averages. Using a

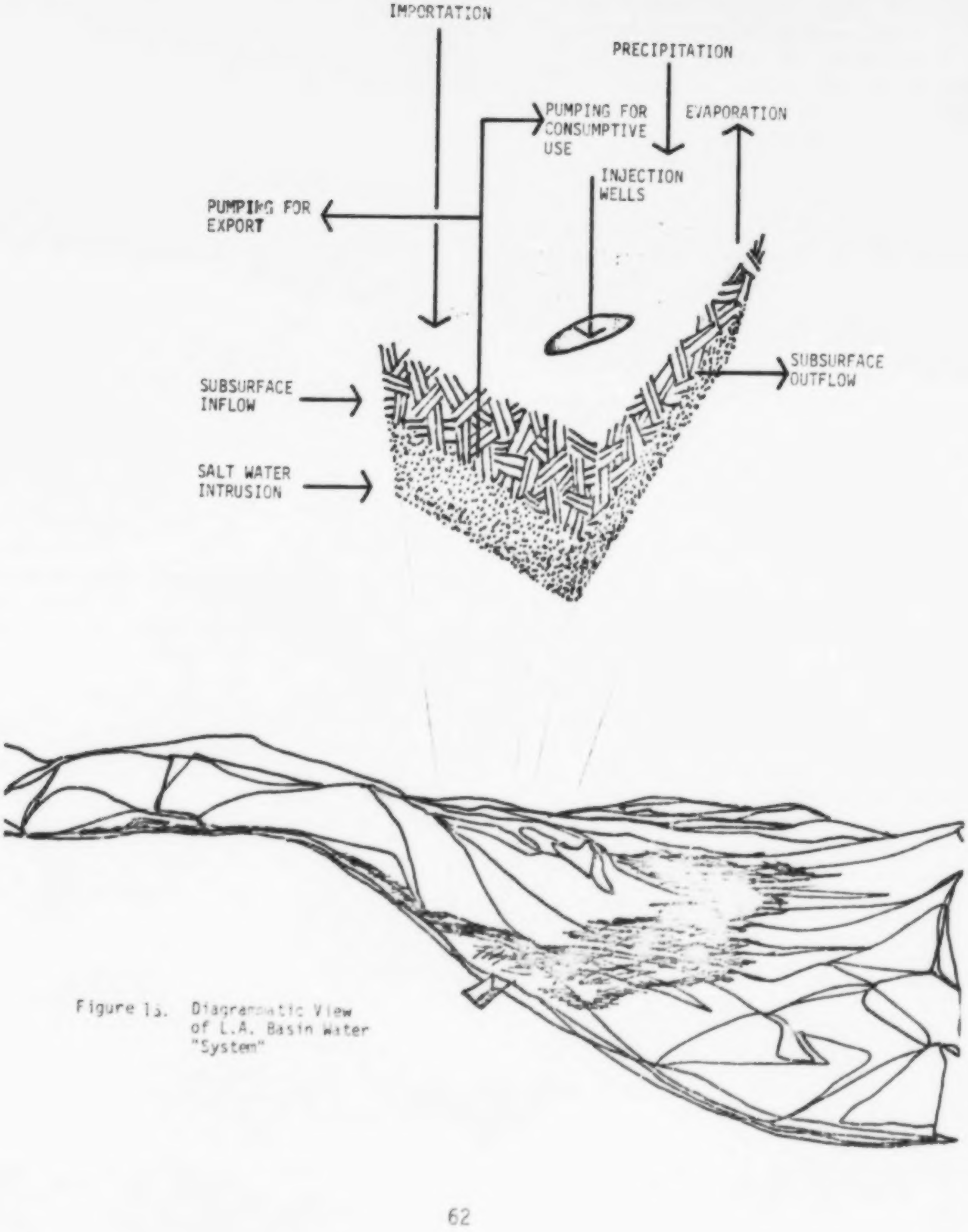

IMPORTATION
PRECIPITATION
PUMPING FOR CONSUMPTIVE USE
EVAPORATION
INJECTION WELLS
PUMPING FOR EXPORT
SUBSURFACE INFLOW
SUBSURFACE OUTFLOW
SALT WATER INTRUSION

Figure 15. Diagrammatic View of L.A. Basin Water "System"

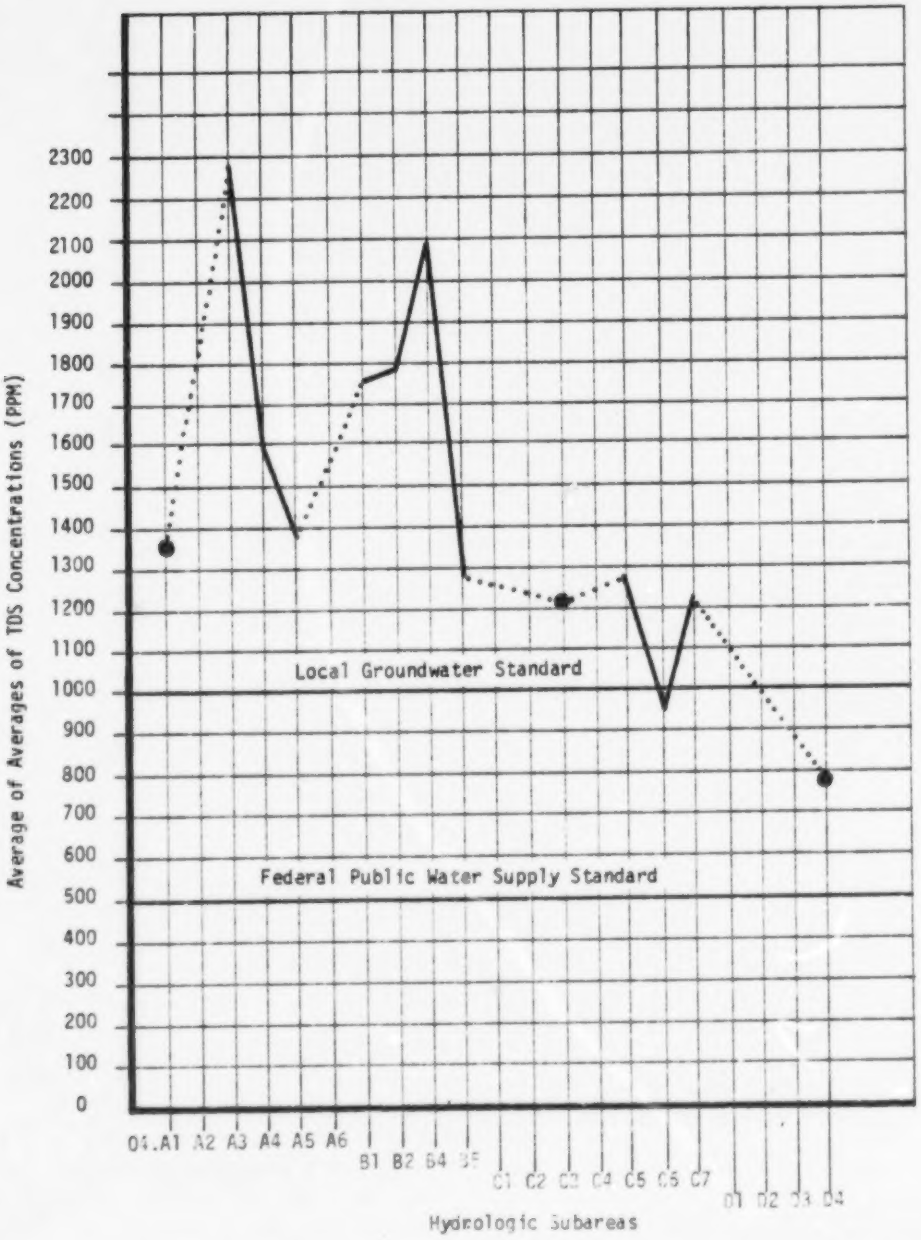


Figure 16. Average of Averages of TDS Concentrations for Santa Monica Mountains and Coastal Malibu, 1900-1974.

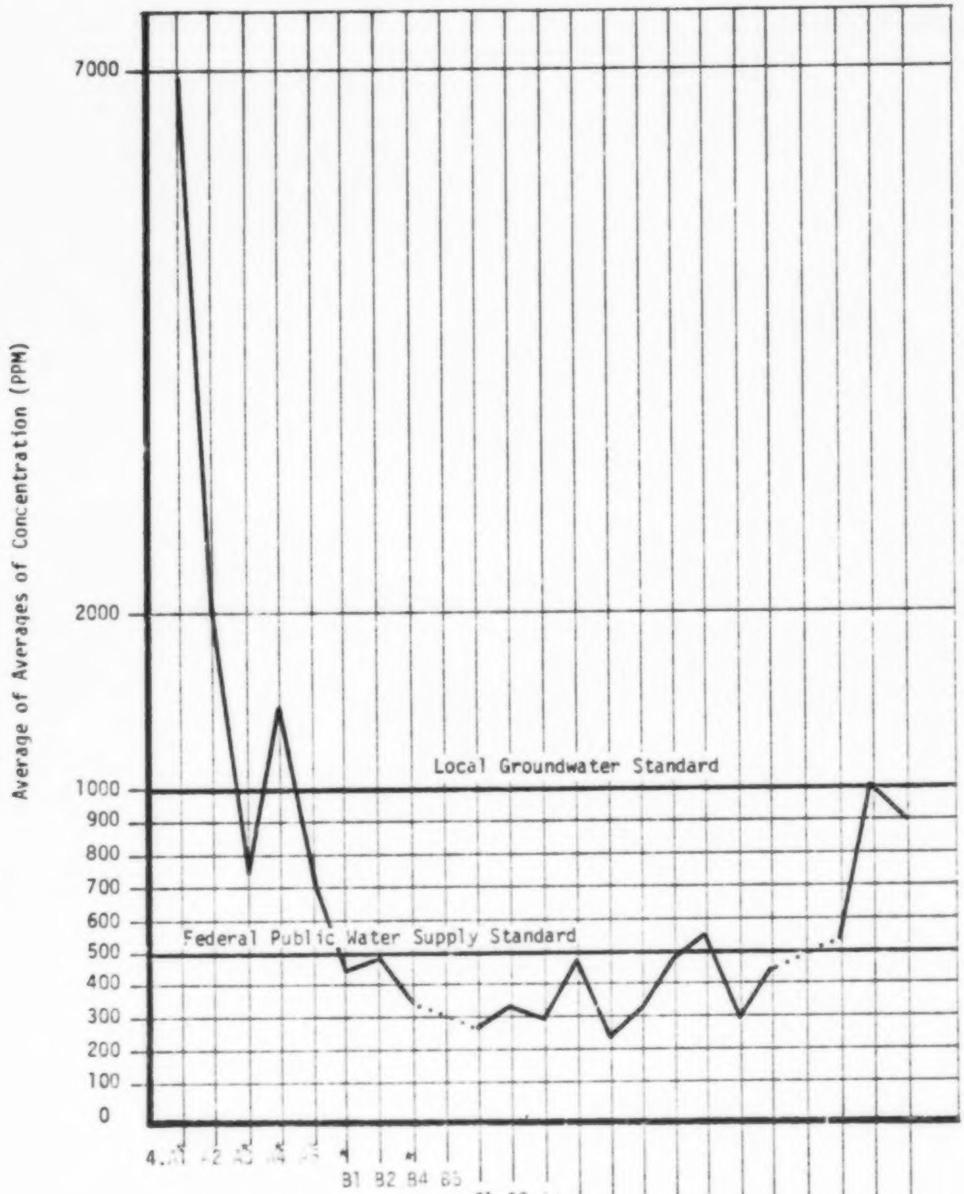


Figure 17. Average of Averages of TDS Concentrations for Coastal L. A. Basin, 1900-1974.

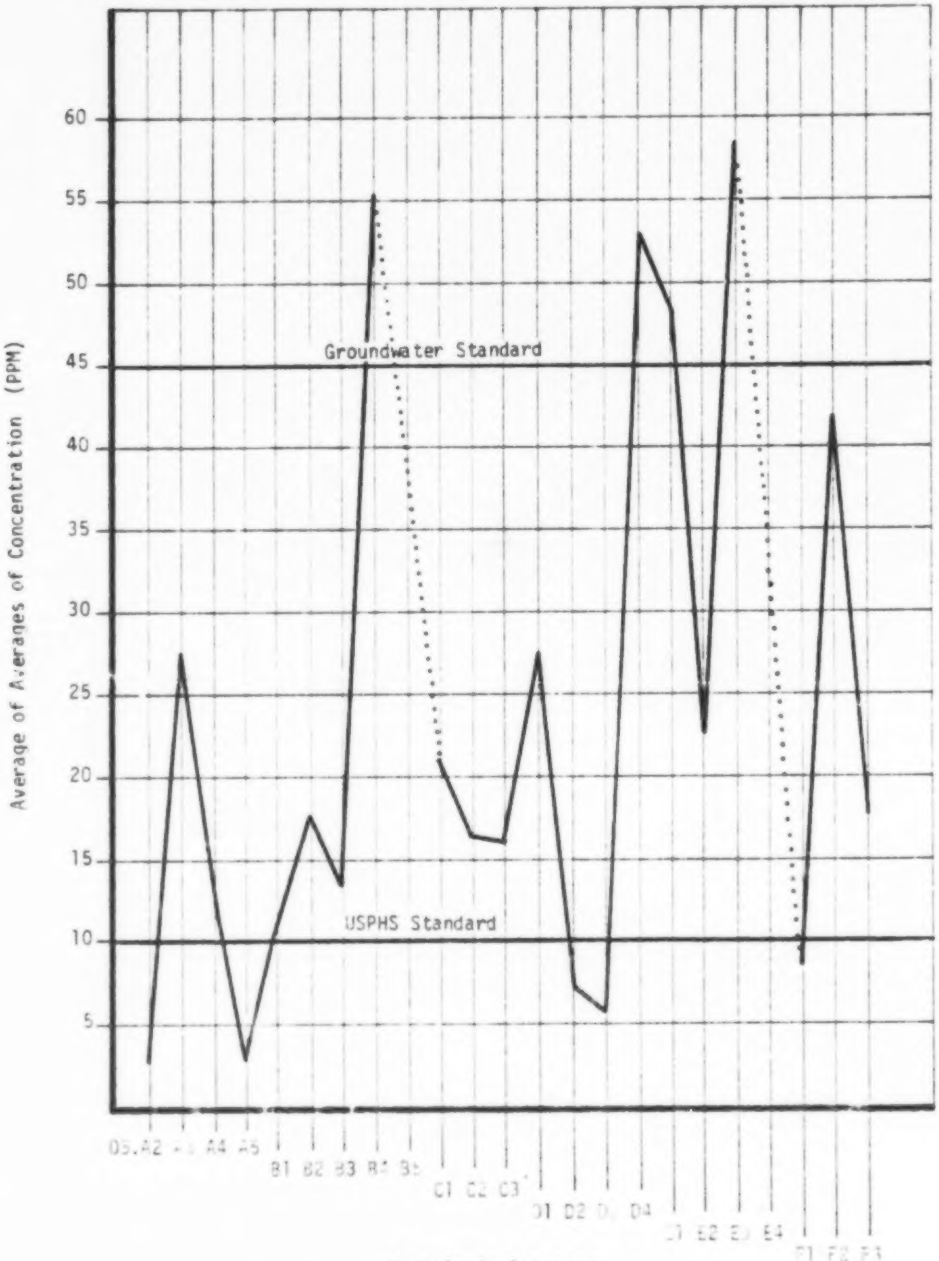
simple average for a time as long as 1900 to 1974 may not obscure the extremes that are encountered in some wells. Consequently, it is more desirable to use average of averages which tends to minimize the influence that extremes have upon measures of dominent characteristics of water quality. This rule of using average of averages was adhered to generally in portraying the historical data contained in this report.

Nitrogen and Nitrates--

The total nitrogen content of water supply in the form in which the nitrogen exists are significant for two reasons. First, excessive concentrations of nitrate can present a health hazard to infants. For this reason, the drinking waters standard of the United States Public Health Service limit nitrates to 10 milligrams per liter measured as nitrogen. Since chemical reactions in the water can oxidize other forms of nitrogen to the nitrate state, it is necessary to give consideration to total nitrogen concentration in the water. Second, the various forms of nitrogen act as oxidates or reductates, and therefore, the form in which nitrogen exists is a factor in the oxidation reduction balance. In simple terms, the measure of total nitrogen content in water supply is also a measure of potential health hazard for human beings if water is consumed. An example of a graph displaying the average of averages for nitrogen concentrations in coastal Los Angeles County ground water for the period 1900 to 1974 is shown in Figure 18. All of the characteristics of this method of portraying data have been discussed previously.

Chlorides--

Chlorides were considered as indicators during this project because of the high degree of relationship between chloride concentrations in the drinking water supply and salt water incursion into the ground water aquafers coupled with percolation of reclaimed waters. In this particular region, this indicator could be used to reflect effects of salt water barrier project for the region, which has been underway since approximately 1960. The graph concerning this indicator covering the period 1900 to 1974 would show that as the area became increasingly urbanized and, therefore, a larger number of wells were drilled to produce water for human use, the concentration of chlorides particularly along the coast greatly increased because of the incursion of salt waters into the fresh water aquafers. However, beginning at approximately 1960 actions on the part of local governments to develop a fresh water barrier project along the coast have resulted in the decline in the concentrations of chlorides in ground waters for the area. An example of the average of averages for chloride concentrations in ground water of coastal Los Angeles basin is shown in Figure 20 . It is clear from this graph that the standard set are generally not exceeded except in those areas where the wells are adjacent to or are in proximity to the ocean, i.e., these are hydrological subareas 4.A2, 4.A3, and 4.A5. Otherwise, the chloride concentrations for all areas of the Los Angeles County basin are below those



*L.A. City Lies Within These Subareas

Figure 18. Average of averages for NO_3 concentrations in coastal L.A. County groundwater, 1900-1974.

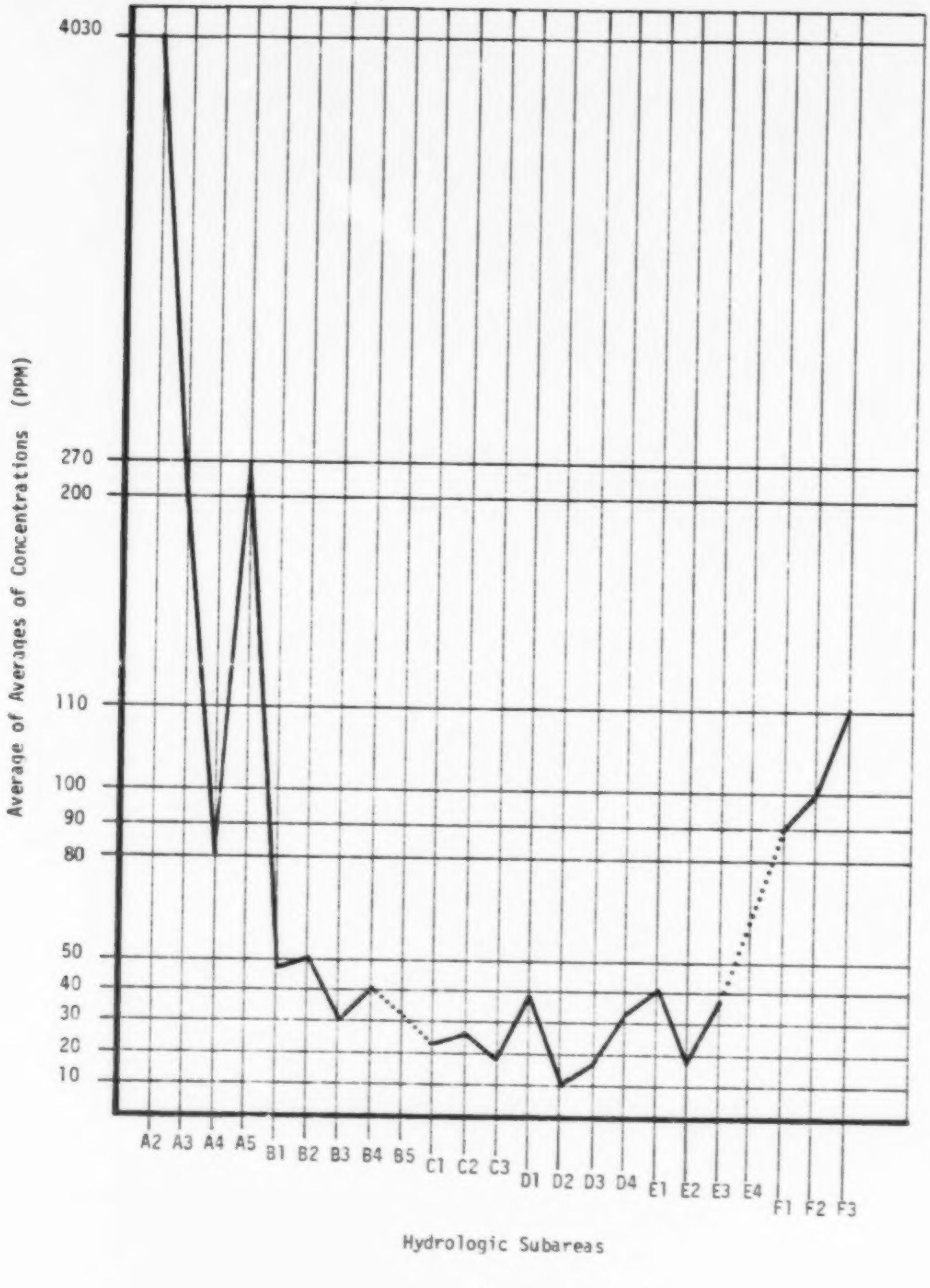


Figure 20. Average of averages for Cl concentrations in groundwater of coastal L.A. basin, 1900-1974.

standards set by the Regional Water Quality Control Board.

Trace Constituents--
This category includes constituents which are undesirable in water supplies in very small concentrations either from the health standpoint or from aesthetic considerations. Most of them are limited by drinking water standards of the United States Public Health Service. Included are both inorganic substances, particularly heavy metals, and organic substances, such as detergents, chlorinated hydrocarbons (which include many insecticides), and phenolic substances (which can inpart undesirable taste to water in small concentration).

An indication of very high quality of the drinking water which is used in the Los Angeles basin can be gained from the fact that the State Department of Health records regarding trace constituents consist largely of blank entries. Blank entries simply mean that the trace constituents are present in such very small amounts that they cannot be registered on the analytical equipment used. In those cases in which trace constituents have been found in analysis, they are generally present in amounts that are as little as 1/100 of the minimum standards set by the federal government. There is, therefore, no graph which displays these very small measures over time

Coliform Count--
Bacterial inpurities of water supplies are evaluated by tests designed to demonstrate the absence of bacteria of the coliform group. Although coliform bacteria are in themselves harmless the presence or absence is an indication of the presence or absence of more harmful bacteria. The bacterial contamination of ground water supplies is not considered a problem as the passage of water through the finely developed basal soil structure above the water table and through the aquafer materials affectively removes any pathogenic bacteria. A high coliform count would suggest that the water possesses a very strong potential health hazard for human use.

Lead--
Lead in ground and surface waters in the Los Angeles coastal region is present in concentrations so insignificant that it is not required as an indicator of ground or surface water quality. However, the presence of lead in the ocean over time is an excellent indicator of the interface that exists between land use of the basin , the air, and the ocean water quality of the area. This indicator would also be of use to those areas in the United States possessing either large fresh water bodies or in proximity to large salt water bodies. Lead in the sediments of San Pedro Basin, shown in Figure 21, measure the deposition of lead contained in lead-based paints, and in the lead transmitted to the air in the consumption of gasoline in internal combustion engines. Consequently, this particular

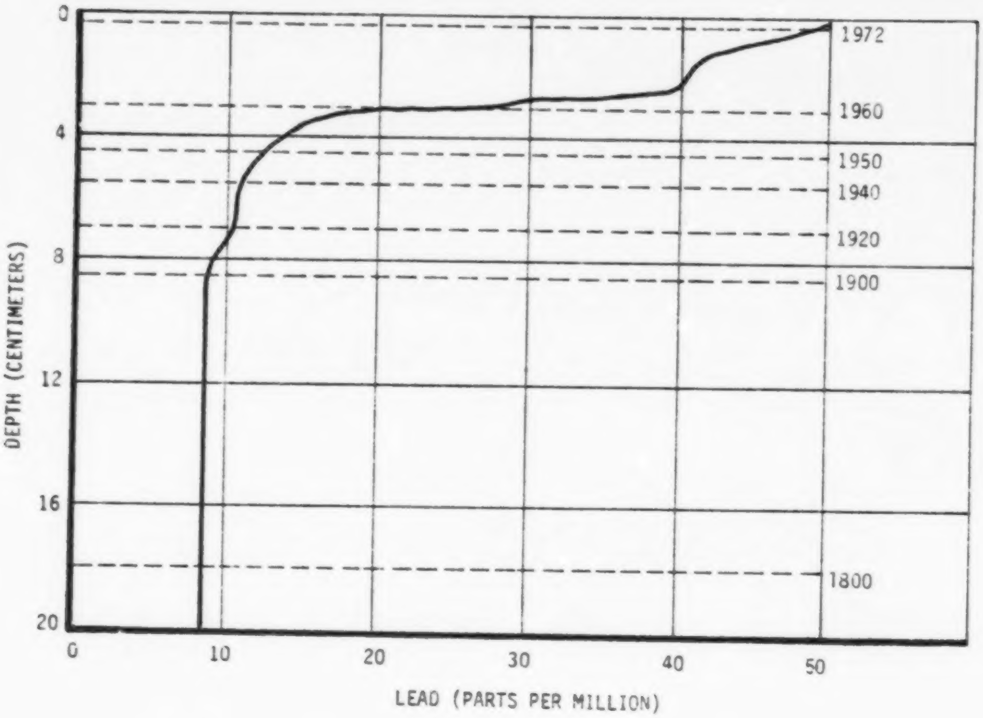


Figure 21. Concentrations in Sediments of the San Pedro Basin (Reproduced from Scientific American, September, 1974, page 23)

indicator is a measure of the high degree of interface that exists between water quality and air quality. However, it measures water quality less than it does measure the interface and air quality. Figure 21 does clearly show that the rapid growth of the concentration of lead in the sediments is a phenomena that is contemporary with, and probably caused by, the rapid urbanization of Los Angeles basin. Consequently, lead is an indicator of the degree or urbaniation.

Ground Water levels--
Knowledge of well levels and the capacity of aquafer soils provides a basis for estimating the net volume of ground water potentially available for use. Since the volume of water in ground water aquafers is not easily calculated, contours of ground water levels are used as an indicator of available supply. At this time, this indicator can only be used to suggest whether the ground water supply could be growing or diminishing, based on fluctuations in water level. An indicator of change in the available water supply is shown in Figure 22 as change in the water level in an indicator well in Los Angeles County. While there are seasonal components to the change in this indicator, it is clear that the degree of urbanization is inversely proportional to the change of the value of this indicator. That is, as urbanization is increased, the amount of water available potentially from the ground has diminished.

Not all hydrographs would possess this long term curvilinear form. This hydrograph was specifically chosen because it directly reflects the decline in the supply of ground water that is inversely proportional to a growing population between 1955 and 1965. However, the graph also shows directly the result of the government program to halt the diminution of supply beginning 1955. Program action included establishment of over draft conditions, increased spreading and injection of imported water, and formation of water users' authority to regulate the ground water supply. As a result of these actions, the potential volume of water available for productive use has increased since the inception of the corrective program. Consequently, this water level indicator is an indicator of change in volume, but also an indicator of the effectiveness of governmental program actions.

Imported Water--
Another dimension of supply is the amount of water imported to maintain the level of local ground water while at the same time meeting drilling water demand. Historically, the demand for ground water has increased to the point where program actions have caused the use of ground water to level off while the volume of imported water has increased dramatically to meet growing demands. The chart in Figure 23 shows the change in the historical balance between the use of imported supplies of water and use of ground water.

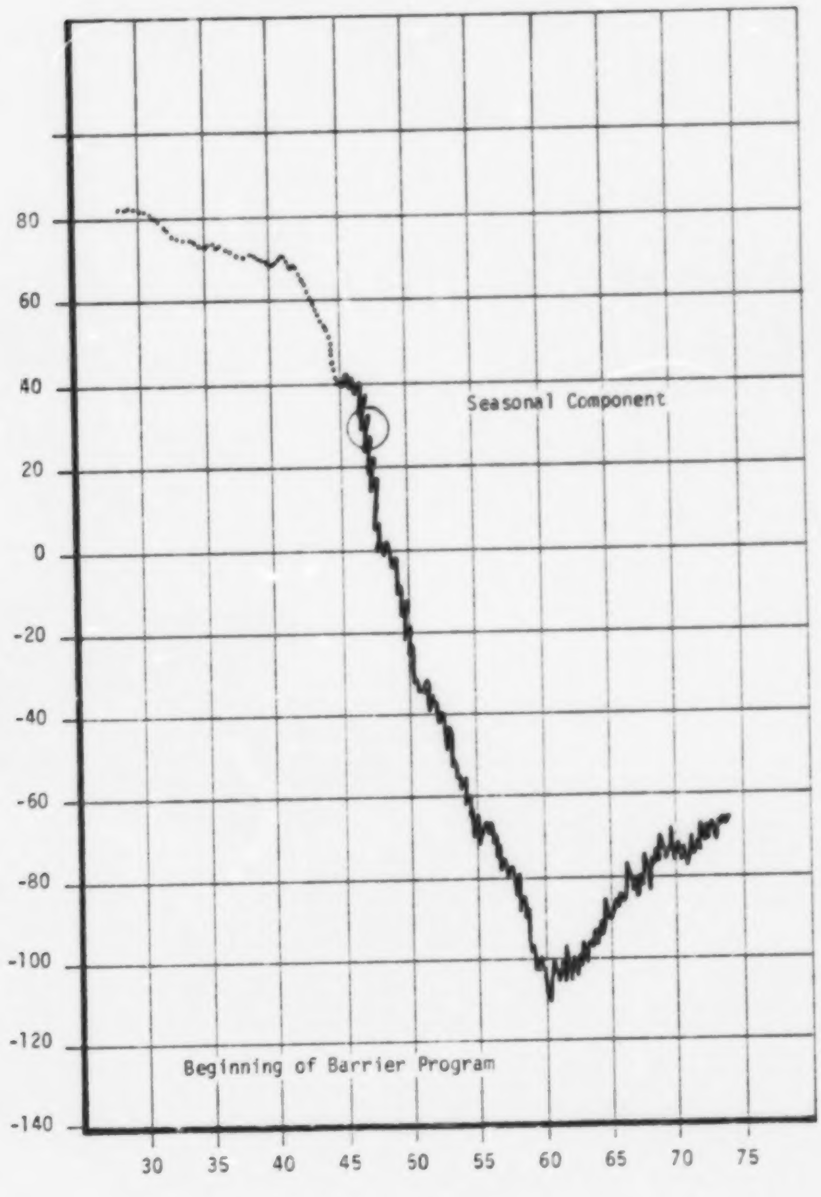


Figure 22. Fluctuation of Water Level in Indicator Wells in Coastal L. A. (Wells 7N/11W-24C1, 7N/10W - 1901)

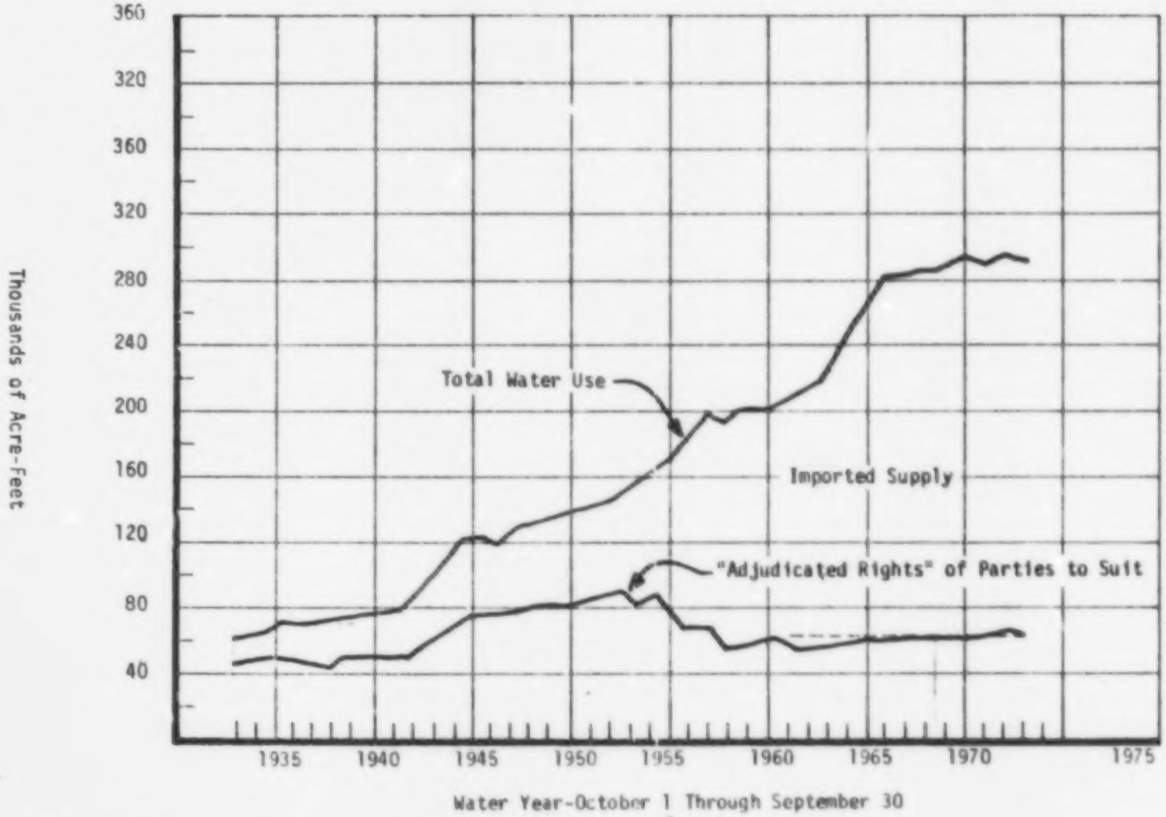


Figure 23. Historical groundwater extractions and total water use, 1933-1973.

Ground Water Replenishment--
Increasingly, communities in the United States are resorting to the replenishment of avialable ground water supplies with water obtained in other ways. Much of the water used for replenishment is obtained through importation or reclamation. Water from these additional sources is then spread on the ground as a means of replensihing the water aquafers or is injected into the aquafers by way of wells. In the Los Angeles region, a large portion of the reclaimed water comes from the Whittier Narrows Water Reclamation Project operated by the County of Los Angeles. This project reclaims water from the sewage treatment process and spreads the reclaimed water in various spreading beds and along the San Gabriel River.

Precipitation and Evaporation--
Precipitation is one, though not uniformally important, component of supply. In the Los Angeles basin the use of a precipitation indicator is not as significant as it would be in those areas where heavy rainfall is characteristic. On those occasions when rainfall is heavy in the basin, the rain striking the surface of the ground generally becomes runoff to the ocean because of the naturally impervious surface soils throughout the basin and the extent of paved over urbanized areas. Nonetheless, the amount of precipitation in a particular period of time is a good indicator of a marginal effect upon the ground water in the area as well as the impact that runoff by way of the improved channels in the area will have upon the composition of the water quality in the ocean.

Evaporation, although not also a uniformly significant component in all cases, is probably more significant in Southern California or in the arid, warm regions of the United States than it would be for those temperate areas in the United States. Tracing this particular indicator is a means of monitoring the completion of the net supply in the basin of water stored in surface reservoirs by the amount of reduction that results from evaporation. Naturally, areas away from the protection of moist ocean air, i.e., those areas in the high desert or mountain areas of Los Angeles County, have a higher evaporation rate.

Rate of Consumptive Use--
Rate of consumptive use water is the most important element on the demand side of the water supply and demand equation. Consumptive use includes water use for drinking, irrigation, sewers, etc. This use is measured in terms of volume of water consumed per capita. The pattern of water consumption in the Los Angeles basin is shown in Figure 24 . It is clear from this particular chart that the rate per capita consumptive use of water has gradually increased over the past decade, but will probably stabilize or decline in the near future as the consequence of environmentalists publicity concerning conservation of natural resources, and a stabilization or decline in the growth rate of the area. In spite of these future possibilities, the trend shown in Figure 24 is that the average per

YEAR	MILLIONS OF GALLONS OF WATER	POPULATION	WATER CONSUMPTION PER CAPITA (GAL./DAY)
1960	102,004	1,740,184	160
1961	105,197	1,759,000	164
1962	100,658	1,772,000	156
1963	100,509	1,793,100	154
1964	105,595	1,814,700	159
1965	102,181	1,829,600	153
1966	106,605	1,851,000	158
1967	107,131	1,867,200	157
1968	114,133	1,902,160	164
1969	114,133	1,917,560	163
1970	117,186	1,850,763	173
TOTAL	1,175,336	20,097,267	
WEIGHTED AVERAGES	106,848	1,827,024	

Figure 24. Historical changes in consumption of water for City of Los Angeles.

day has increased in the ten-year period at virtually the same rate as the increase in population. This reflects disproportionate increase in consumptive use of water as a function of new technological resources being available to people who are consumers of water.

Transfer of Project Results

There are a number of important conclusions from this research on the development of water quality and quantity indicators which relate to other areas in the United States. These conclusions are briefly described below:

1. The number of national agencies involved in the collection of water data which can be used in the development of indicators is quite large. Although these nationally oriented agencies do not collect data at a highly disaggregated level, they nonetheless provide a very large volume of data where those data reflect the impact of components of the water system upon the concerns that are nationwide. For example, the Department of the Interior and the Agriculture Department both collect information on the volumes of water stored or flowing in reservoirs, lakes, and streams throughout the United States. This data is readily available which is one of its advantages and also available for a continuous time period that covers anywhere from ten to the past 100 years.

2. There are an increasingly large number of local agencies who are involved in data collection in connection with water. Increasingly also, because of national emphasis upon standard sets of data and because of the encountering of common problems to local areas, the data collected by these agencies has begun to possess a consistency that makes comparison of the various water systems in the United States possible. The research during this project made maximum use of this data from local agencies.

3. The indicators developed in connection with this project are simple to prepare, possess a direct relationship to very specific water system characteristics, directly relate to the specifice actions of water agencies, and can be generally obtained from agencies in the local environment.

4. It is reasonable to collect data on water quality and quantity by geographical units that are natural for the water system than by some arbitrary unit such as census tract. Conversion of the indicators to a census tract basis can be performed by computer using an interpolation table that defines the hydrographic units to be involved in each census tract.

LAND USE

Introduction

The work completed during this project included research into the development of indicators of land use for the Los Angeles Metropolitan Area. The purpose behind the development of these indicators was to produce a means of determining the patterns of land use for the Basin and changes in those patterns over time. These indicators were in turn intended to be used as a basis for governmental action to influence patterns of land use in various ways. While the research focused upon Los Angeles County, the indicators addressed are characteristic of work done in the same area in other jurisdictions in the United States. This means that the indicators that were addressed provide a means of characterizing land use patterns and changes in very general terms and provides also a means of moving from those general indicators of land use changes to more specific indicators of land use change. Unlike other areas addressed in this research project, land use is not primarily an objective, physical pehnomena. As a result, it does not have simple and clear-cut measures of change such as water quality. Land use indicators are measures not only of some aspects of physical changes of characteristics of land, but also of economic, social, and political changes. These additional aspects of land use indicators makes the development of truly useful indicators a very difficult task.

Data Available

The rationale for data collected during this research project was that it be used to produce indicators whose changing values would reflect the reality of changing pattern of land use in the local area. As a means of focusing this data collection process, the land available within the Los Angeles County Basin could be conceived of as part of a closed and highly interrelated system. This system involves the interaction of physical forces that prevail on any given portions of the land as well as all of those sociological, economic, and political forces which influence the change of the use of land. This system thus involves a very, very large number of complex forces, the characterization of which in any simple fashion through the use of indicators will inevitably be an oversimplification. Nonetheless, as with economic indicators, some indicators of change, even in a very general fashion, are desirable as a means of guiding further study of land use patterns as well as action with regard to the way in which those patterns are developing.

Perhaps the complexity of the interaction of various forces in connection with land use for the Los Angeles Metropolitan Area can best be illustrated by reference to the area of land involved and to the number of agencies who have a direct or indirect legal responsibility with regard to land use. First of all, the number of parcels of land for which indicators would provide some indication of patterns of change involved for the County of Los Angeles is very large. In Los Angeles County, there is approximately 4,080 square miles of land that is broken into 1,800,000 parcels of land. Directly or indirectly involved in the control of the way in which land in these parcels is used are 78 city governments, 1 county government, 1 state government, numerous commissions such as the California Coastal Zone Conservation Commission, all of the private individuals who in one way or another occupy the parcels of land and the developers and financial institutions who are providing forces directed toward development of parcels of land. All of these agencies are involved in the preparation of data regarding the way in which land is used at the same time that they are involved in the process of modifying the pattern of land use by virtue of their actions with regard to individual parcels in the area. Consequently with all of these, plus the physical forces that are acting upon the land involved in land use patterns throughout the area, it is clear that the indicators developed in terms of land use must involve the aforementioned financial, economic, sociological, physical, and political dimensions. To a greater or lesser degree, all of the noted agencies are involved in data collection which supports the development of indicators such as noted above. The various agencies contacted in connection with this project are listed below:

Los Angeles County Regional Planning Commission
Los Angeles City Planning Department
State Department of Water Resources
Los Angeles County Assessor's Office
Private development companies
Private financial institutions
Federal agencies
Southern California Edison
South Coast Regional Commission
Southern California Associations of Government

The two agencies in the region who have been involved in the most continuous and consistent programs of collection of data in connection with land use are the Los Angeles County Assessor and the State Department of Water Resources. Under its enabling legislation, the State Department of Water Resources has been given the charter to regularly conduct land use surveys for specific areas within the State of California. These surveys are based upon aerial photographic imagery which is collected by the Department and analyzed using the Department of Water Resources' classification of land use types. This analysis results in the production of a map for given areas which portrays the change in the amount of land for various general land use categories. The land use categories used in this analysis are shown in Appendix B. For the Southern California area, these land use surveys have been conducted at approximately five year intervals since the 1950's. Frequency of collection of data regarding land use is somewhat more frequent for the County Assessor's Office than for the Department of Water Resources. The County Assessor's Office, through the operation of its appraisal system, regularly visits land parcels throughout the County as a means of determining not only the use to which the land is being put, but also collects a great deal of other data which provides insights into the economic, social, and physical characteristics of parcels of land. All of this data is assembled as part of the Assessor's parcel file, which is used by that office to fulfill its primary charter, i.e., the recording of values as the basis for computing taxes and the production and mailing of tax bills to owners of properties in the County. Land use codes employed by the Assessor's Office are shown in Figure 24a.

Perhaps the most objective and most continuous program related to the collection of data for land use indicators is involved in the production of aerial photographs of various portions of the Los Angeles County. This photographic imagery prepared at various scales is a record which is nearest to reality of all those data sources available. The photographs simply record the condition and use of land as it existed in any one point in time. These photographs are thus always available as a basis for individual agency production of land use surveys involving the interpretation of various land use categories in highly individualistic ways. An example list of some of the aerial photographic imagery that is available for the Los Angeles County area is provided in Figure 24b.

Rationale for Indices

The indicators of land use provided in this report are neither the most desirable from many points of view nor the most specific. It would require an extensive documentation to provide the detailed land use indicators which would be found to be of most use to specific local governments in taking specific actions within the area. Consequently, only those indicators were developed which provide the most general of insights into the way in which land use patterns in the County have materialized and the way in which those patterns are currently changing. The indicators that have been chosen and provided in this document were chosen for the following reasons:

They are currently in use among agencies concerned with land use.

The indicators are based on readily available data which has a broad use and meaning.

A fair amount of research has gone into producing these indicators.

These indicators are the basis on which new and more useful indicators could be developed.

PROPERTY USE CLASSIFICATION CHART

RESIDENTIAL

00

01 SINGLE

3rd digit - 0
4th digit
T Pool
C Condominium
D Planned Res
Development

02 DOUBLE OR DUPLEX

03 THREE UNITS (ANY COMBINATION)

04 FOUR UNITS (ANY COMBINATION)

05 FIVE OR MORE APARTMENTS OR UNITS

3rd digit
0-4 stories or less
5-5 stories and over

4th digit
T Pool
A Cooperative
B Own-your-own

06 HOTELS-MOTELS (1-3 story)

07 HOTELS (MULTI-STORY)

08 ROOMING HOUSES

09 MOBILE HOME PARKS

COMMERCIAL

10 Vacant Land

11 STORES

12 STORE & OFFICE
RESIDENTIAL COMB.

3rd digit
T Residential
Combination

4th digit

13 DEPARTMENT STORES
(MULTI-STORY)

14 SUPERMARKETS
(8000 sq. ft. or more)

15 SHOPPING CENTERS
(Neighborhood, Community)

16 SHOPPING CENTERS
(Regional)

17 OFFICE BUILDINGS, 1 STY

18 OFFICE BLDGS. MULTI-STY

19 PROFESSIONAL BLDGS.

COMMERCIAL

20

21 RESTAURANTS
COCKTAIL LOUNGES
DRIVE-IN COFFEE SHOPS, ETC.

22 RECREATION (ENCLOSED)
DANCE & MUSIC SCHOOLS
POOL HALLS
THEATRES (ENCLOSED)

23 FINANCIAL INSTITUTIONS

24 SERVICE SHOPS
RADIO & TV REPAIR
REFRIGERATION SERVICE
PAINT SHOPS
ELECTRIC REPAIR
LAUNDRIES

25 SERVICE STATIONS

26 AUTO SALES, REPAIR & STORAGE, AUTO SERVICE SHOPS, BOAT SALES, BODY & FENDER SHOPS. GARAGES (COMMERCIAL), Limited to Service or Repairs, FARM MACH. SALES & SERVICE

INDUSTRIAL

30 Vacant Land

31 LIGHT MANUFACTURING
SMALL EQUIP. MANUFACTURING
SMALL MACHINE SHOPS
INSTRUMENTS MFG.
PRINTING PLANTS

32 HEAVY INDUSTRIAL

33 LUMBER YARDS

34 PACKING PLANTS
VEGETABLE PACKING PLANTS
MEAT PACKING PLANTS

35 CANNERIES
FRUIT & VEGETABLE
FISH

36 OTHER FOOD PROCESSING
BREWERIES
BAKERIES
CREAMERY

37 MINERAL PROCESSING
CEMENT PLANTS
GRAVEL PLANT. SAND.
ROCK, BATCH
CLAY PRODUCTS
REFIENERIES OR CHEMICAL CO.

38 WAREHOUSING
DISTRIBUTING TERMINALS
TRUCKING TERMINALS

39 OPEN STORAGE

IRRIGATED FARM

40

4010 PRIVATE RURAL
PUMPING PLANT

41 FRUITS & NUTS

42 VINEYARDS

43 VINE & BUSH FRUITS

44 TRUCK CROPS

45 FIELD CROPS

46 PASTURE

47 DAIRIES

48 POULTRY, ETC.

49 FEED LOTS

DRY FARM
50

51 FRUIT & NUTS

52 VINEYARDS

53 FIELD CROPS

54 PASTURE

55 TIMBER-PINE

56 TIMBER-FIR

RECREATIONAL

60 Vacant Land

61 DRIVE-IN
THEATRE

62 NIGHT CLUBS

63 BOWLING ALLEYS
SKATING RINKS

64 CLUBS
LODGE HALLS
DANCE HALLS

65 AUDITORIUMS
STADIUMS
AMUSEMENT
PIERS

66 GOLF COURSES

67 RACE TRACKS

68 CAMPS

69 PARKS

INSTITUTIONAL

70 Vacant Land

71 CHURCHES

72 SCHOOLS

73 COLLEGES

74 HOSPITALS

75 HOMES FOR AGED & OTHERS

76

77 MORTUARIES, CEMETERIES,.
MAUSOLEUMS

78

79

MISCELLANEOUS
80

81 UTILITY
Commercial & Manual Pumping
Plants, State Assessed Prop.

82 MINING

83 PETROLEUM & GAS

Figure 24a. L.A. County Assessor Land Use Code

Aerial Photographs

'Acquisition & Availibility (Black and White)

YEAR	CO.	AREA	DESIG.	SCALE	COSTS			
1960	Teledyne	L.A. Basin	C 23870	1:14,400	1950-1965 Photos:			
1961	Teledyne	San Fernando V.	24040	1: 6,000	1st 50: $5.76 ea.			
"	"	"	24068	"	$1.80 ea. thereafter.			
1962	Teledyne	Santa Monica	24385	1:14,400	1965-1974 Photos:			
		to Norwalk			1st	10	50	100
1962	Teledyne	Los Angeles	24440	1:12,000		$13.344	$4.	$2.4396 ea.
"	"	"	24455		After:	$12.96	$1.44	$1.08
1961	Teledyne	Los Angeles & Ventura Co.	C 24153	1:12,000				
1971-Apr.	Teledyne	L.A City	-----	1:12,000				
1973-Feb.	Teledyne	L.A. City	-----	1:24,000				
1969-Oct.16	Fairchild	L.A. City	-----	1: 4,000	Roughly the same as Teledyne			
1973-Oct.12	Fairchild	L.A.	-----	1: 4,000				
1970-Jan.	VTN^c	L.A.	-----	1:48,000	Roughly $25. ea.			
1972-Apr.	VTN	L.A.	-----	1:48,000	" " "			
1974-June	VTN	Santa Monica Mtn.	-----	1: 6,000	Unknown			

Orthophotos can be constructed by teledyne and VTN for about $200. per "neat" photo. Cost for photomosaic: $30. per original negative, $60. per copy negative, $7. per sq. ft. of mosaic.

(a) Teledyne Geotronics, 725 East Third Street, Long Beach, California. 90802
Ask for Quincy (213) 435-8326, or (213) 775-1059.

(b) Fairchild Aeromaps, 14437 North 73rd Street, Scottsdale, Arizona. 85254
Telephone: (500) 528-7350.

(c) VTN, Associates, 2301 Campus Drive, Irvine, California. 92664
(714) 833-2450, ask for David Morales.

Figure 24b. Partial Listing of Aerial Photographic Imagery for L. A. County

It is important to note with regard to the last item that a really satisfactory development of land use indicators for the area would involve an extensive statistical analysis of data for all the 1,800,000 parcels in the County for a number of points in time in the past. A project of this sort is eminently worth considering to be undertaken by an agency possessing both the financial resources and the operational charter to be involved in such a project. That agency would most likely be the Regional Planning Commission for the County of Los Angeles.

The indicators selected for the area of land use are those which reflect changes in the amount of land use for various purposes over time. Specifically, the indicators reflect the changing balance between agricultural and urban-suburban land use, the growth and consumption of total habitable vacant land, number of acres per capita, various uses, and the changing balance between specific land use categories.

Indices and Their Meanings

Usage Shift Indicator--
Urban-Suburban Agricultural Land Use Balance. One of the most significant social and economic characteristics of change in our society in the past hundred years has been the changing balance which exists between agricultureture and urban-suburban land use. Consequently, an indicator which reflects this changing use is one which also represents the change in social patterns of people in the United States, i.e., their tendency to move into metropolitan areas and reflects a major change in the economic characteristics of land use within given governments, i.e., the change in value associated with productive agricultural land as opposed to the increased value of land used for urban purposes. This change characteristic of most areas in the United States is even more dramatic in the case of coastal Los Angeles. The characteristic of this change for Los Angeles has been that the agricultural use of land within the County has dramatically diminished as the amount of use of land involved in urban and suburban development has greatly increased. The change in balance between these two uses from 1880 to the present for the Los Angeles County area is shown in Figure 24c. The predominance of agricultural land use diminution is such that no use of this type has projected to remain by the year 2000. Specifically, the largest amount of land disappearing from agricultural use is in the San Fernando and San Gabriel Valleys. In spite of this change, twenty-three percent of the San Fernando Valley land is still zoned for agricultural usage. In the same period of time, the urban-suburban use of land has increased from some few thousand acres to an estimated 675,000 acres in 1974. Characteristics of this change in balance between urban-suburban and agricultural land use patterns is also shown in the form of a map for the period of 1955-1960 shown in Figures 24d and 24e .

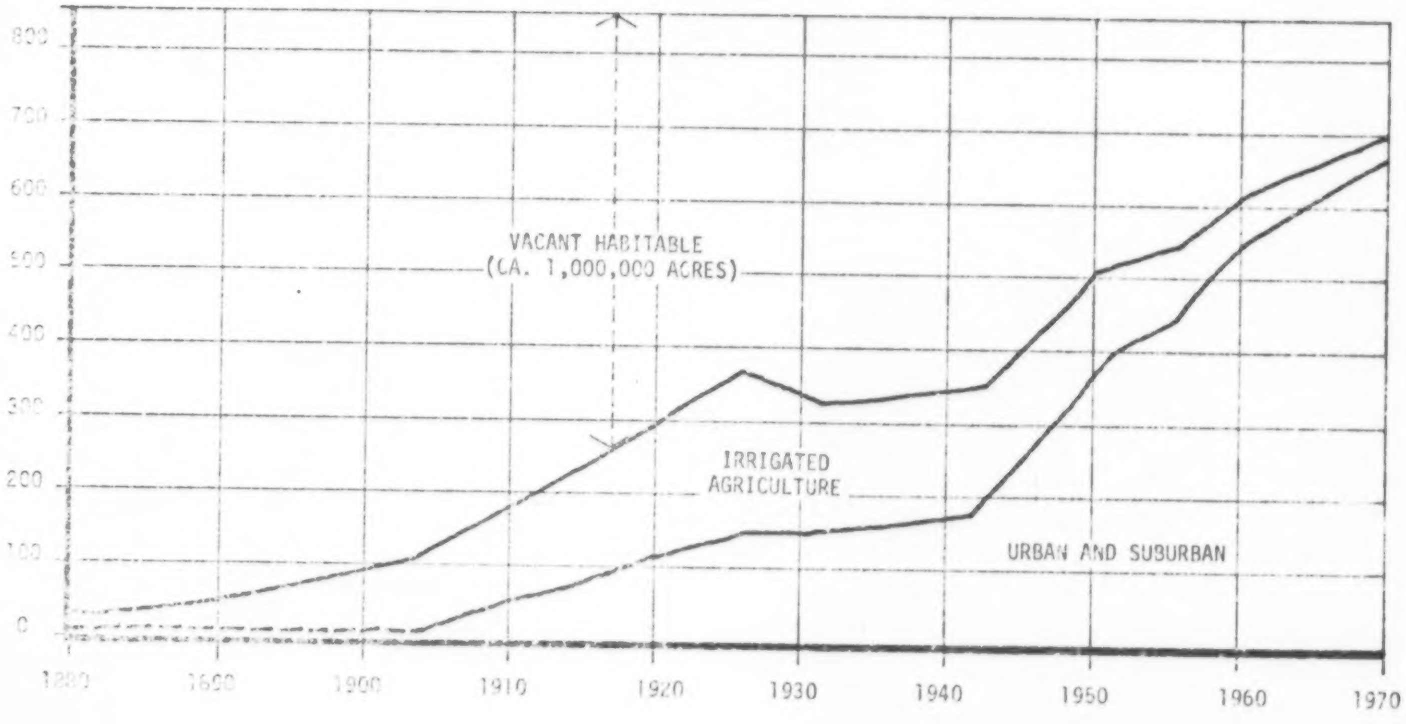


Figure 24c. Historical Pattern of Land Use in Coastal Los Angeles County

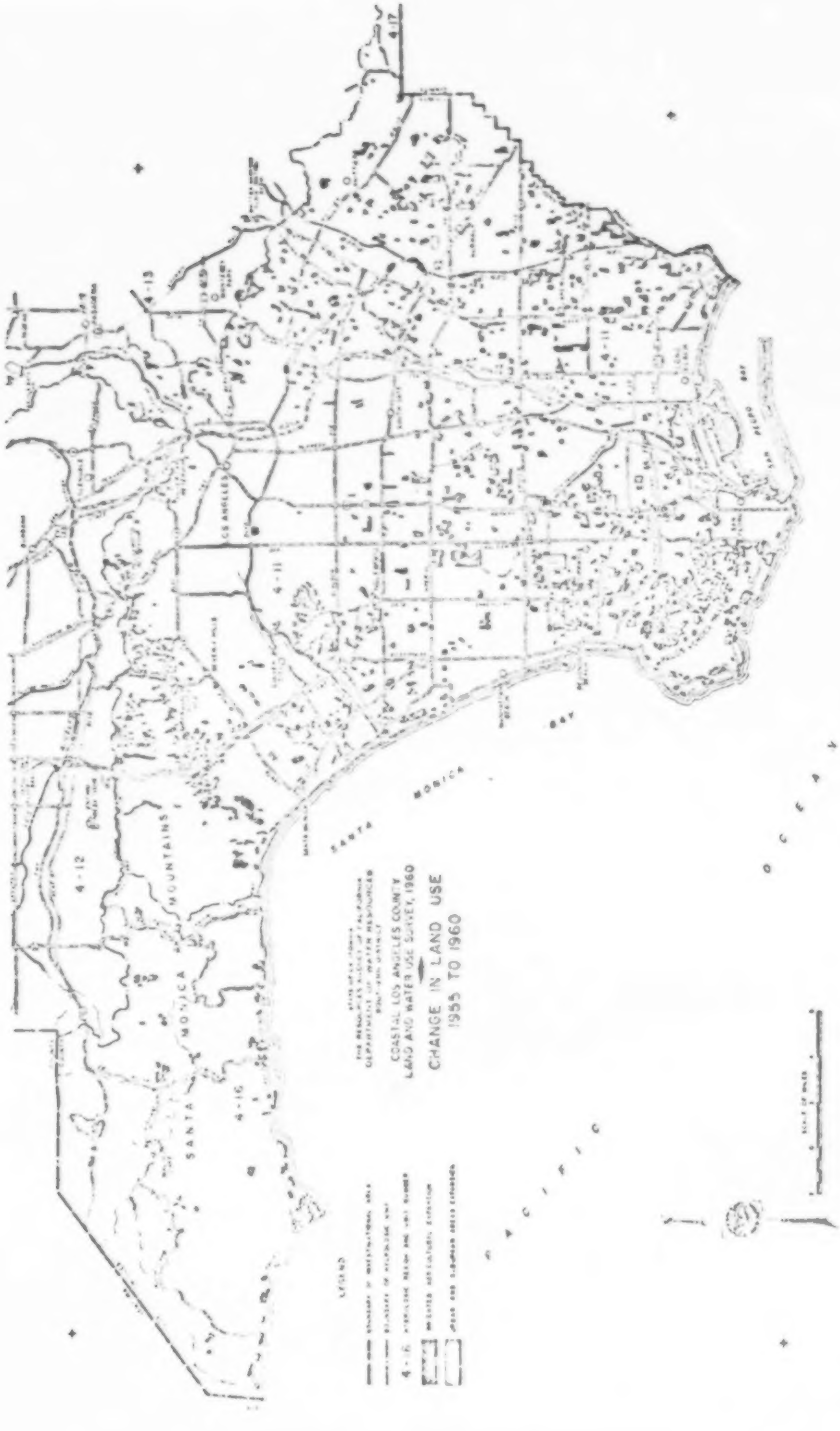
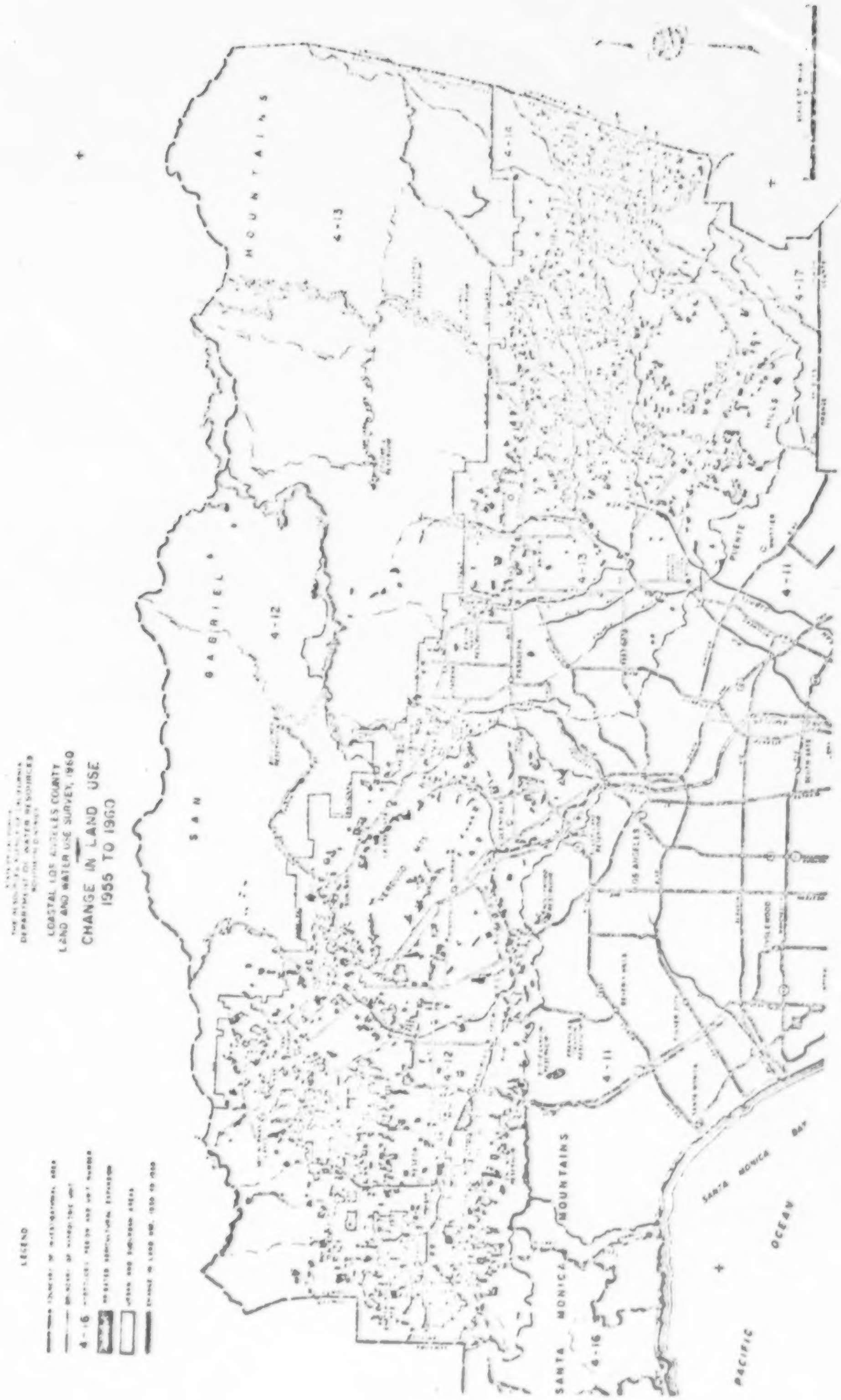

COASTAL LOS ANGELES COUNTY
LAND AND WATER USE SURVEY, 1960
CHANGE IN LAND USE
1955 TO 1960
LEGEND
SANTA MONICA MOUNTAINS
SANTA MONICA BAY
PACIFIC OCEAN
SAN PEDRO BAY
LOS ANGELES
4-12
4-16
4-11
4-13
4-17

Figure 24d.

Reproduced from best available copy.



COASTAL LOS ANGELES COUNTY
LAND AND WATER USE SURVEY, 1960
CHANGE IN LAND USE
1955 TO 1960
LEGEND
SAN GABRIEL MOUNTAINS
SANTA MONICA MOUNTAINS
SANTA MONICA BAY
PACIFIC OCEAN
LOS ANGELES
4-11
4-12
4-13
4-16
4-17

Figure 24e.

Reproduced from
best available copy.

There are a number of specific meanings which can be associated to this change in balance of land use for the area. First of all, of course, there is a distinct change in the physical characteristics of the land involved. In the agricultural usage, the land is generally predominantly open and probably green, being occupied by growing products of the land. There is thus a distinct physical difference between these two usages of land which influences not only the physical characteristics of the underlying soil, for example in the transmission of rain falling upon the land, but also represents a change in the design characteristics of the community in which the land is sited. Secondly, the change of land use between urban-suburban and agriculture represents a major change in the economics of local government operations. There is a different structure in the value associated with land when it is used for agriculture than when it is used for suburban-urban purposes. The agricultural use represents the production of a specific financial benefit which contributes to the area gross economic product, while at the same time agricultural land does not generally require large amounts of services and facilities provided by local governments. At the other extreme, urban uses of land imply a different form of value to the society which does involve the provision of facilities and resources by the local government. Both of these different uses reflect an entirely different structure of the tax system associated with that particular land use.

Third, the sociological characteristics of the two sets of uses are widely divergent. The characteristics of the urban as opposed to the agricultural community can be measured in a number of different ways. These different measures are also indicators of land use patterns. If one were to analyze the urban-suburban agricultural land use balance in specific terms, the indicators used may involve changes in crime rates, changes in the incidents of fire, population densities, family income characteristics, etc.

Total Habitable Land--

Whereas the previous indicator is one that relates all of the social, economic, physical, and political characteristics of land in a very simple measure, there are specific physical limitations on the total amount of land that is available for occupancy. Consequently, an indicator that involves the total amount of habitable land is a measure of the amount of land resources that are available for human use. Thus, this indicator is a measure of the physical boundaries on available land. It is estimated that in coastal Los Angeles there are approximately 1,000,000 acres of land that can be occupied. These acres represent an upper though not absolutely unchangeable boundary of area available for urbanized uses. Any expansion beyond this amount would certainly represent a new characteristic in the way in which available land can be exploited. This characteristic may involve the introduction of new technological features of building structure which permit the development of land which is not now habitable. Presently, about sixty-seven percent of the habitable land is used for urbanized purposes. Based on past rates of land use of this habitable land, it is projected by the year 2000 only twenty percent of unused habitable land will remain for urbanized development. The use of this indicator for planning purposes would suggest that long-range strategic planning for the area must consider either the introduction of new technological capabilities to exploit presently uninhabitable land or make provision for serious changes in the way in which the remaining habitable land resource can be occupied and used.

Urban Use Change Index--
The most important overall single influence upon the balance of land use and the patterns of land use within the area is the way in which that usage is disposed in terms of the prevailing population. A simple indicator which can be used to measure the relationship between land use and population is the number of acres, or the unit of measure of land, in various specific uses in terms of the population resident or occupying that land. For example, in the period from 1960-1972, see Figure 24f, the amount of land available for various specific uses had changed. The increase in number of acres of land used for residential, commercial, and industrial purposes has been 170,000 acres or 14,167 acres per year for that time period. Some of this increase can be accounted for by the 38,719 acres lost from agricultural use. The balance of the acres were obtained through the conversion of previously vacant and uninhabitable land. Such loss of open space and agricultural land may not necessarily be good. This indicator would therefore suggest a review of local government policy that continues to allow depletion of useable open space and loss of productive agricultural land. Studies in Ventura County suggest that there is a net benefit to the public and government from agricultural land use and a net loss from urban-suburban usages.

Data also show that the acres of land per 1,000 population have diminished except for agriculture and open space uses. This represents a general increase in population density which nonetheless is not as great as in other metropolitan areas. It is not as great for the simple reason that the amount of land available for exploitation within the County is very large.

Conclusions

There are a number of important conclusions related to the research that is being conducted in the development of land use indicators which possess potential benefit for other areas in the United States:

These conclusions are briefly described below:

1. There is a plentiful supply of information available through such sources as the tax assessment function within local governments, which can be the source of data for indicators. Generally,

	TOTAL ACRES		PERCENT LAND USE		CHANGE IN PERCENT LAND USE
	1960	1972	1960	1972	
Residential	262,375	399,778	30.5	37.0	6.5
Commercial	28,008	40,013	3.3	4.0	0.7
Industry	51,357	72,146	6.0	6.8	0.8
Transportation/ Utilities	31,388	31,075	3.7	3.0	-0.7
Public Service	76,953	76,621	9.0	6.2	-2.8
Recreation	34,426	33,954	4.0	3.2	-0.8
Agriculture	58,507	19,788	7.0	2.0	-5.0
Open Space	316,053	339,187	36.8	37.8	1.0
	859, 067	1,012,562	100.0	100.0	

Figure 24f. Land Use Characteristics for Los Angeles County, 1960 and 1972

of course, for all jurisdictions within the United States there are taxing functions which provide this data.

2. In similar fashion for most states in the United States, there is an agency responsible for water resources. Also, very frequently this particular agency possesses either the authority or the capability to conduct land use surveys for the state. They are generally involved in this pattern of activity for the simple reason that the consumption of water possesses a very direct relationship to the types of land use prevailing in any given area.

3. There have been very few really satisfactory indicators of land use developed for any local government within the United States. The principal reason for this difficulty is the fact that land use is not a single-valued function. Land use involves social, economic, political, and physical characteristics of the land. Consequently, an indicator must possess a large number of dimensions to reflect all of these characteristics. It would be useful to most all other governments in the United States for a project of experimentation into the development of these complex indicators.

4. The indicators that have been developed during this project are of a very general nature. In order to possess the large amount of use for specific local programs, the component specific indicators of those indicators already described should be developed.

SOLID WASTE

Organization of Activity

In the City of Los Angeles solid waste management is divided between the public sector, under the Bureau of Sanitation, and the private collectors. The Bureau of Sanitation offers service to residential units under a rigid set of conditions. Their service is curbside in containers with a liquid capacity of less than 45 gallons, or tied bundles with maximum dimension less than four feet and gross weight of less than 80 pounds. These restrictions were formulated in 1957 and are oriented to the single-family residential unit despite the shift in housing patterns from single-family to multiple-family units.

Private collectors service the business and industrial interests in the City. The Department of Environmental Quality in the City of Los Angeles estimates that the private collection industry is currently collecting somewhere around 2.3 million tons per year. Because of the rules under which the Bureau of Sanitation solid waste management services are offered, the larger multiple-dwelling unit complexes are increasingly opting for the custom service offered by the private solid waste management firms. Solid data on the portion of dwelling units using this service is not available. The best estimate is 35% of the total housing stock.

The Los Angeles County Sanitation Districts do not cover the entire County, but they do service major population centers. Their main function is liquid sewage treatment, but they also operate sanitary landfills. A limited garbage collection service is operated by the County Engineer. There has been close cooperation between the City and County Sanitation Districts. The County Sanitation Districts have established a sanitary landfill within the boundaries of the City of Los Angeles, for example. Decisions on where solid waste will be disposed are based principally on travel costs. If a county-run landfill is closer than the city landfill, disposal will be at the County site.

Data Available

Data was collected on the costs of collection and disposal of solid wastes within the City of Los Angeles. Private collection data was not available. Thus, the available data primarily includes collection disposal from single family and small multiple dwelling units. Also, data from the Refuse Sampling Program was collected because of significant changes in the composition of solid waste generation.

The difficulty in the assessment of solid waste management in the Los Angeles area is the specialization of services by the City and County and private companies in the County as to the amount and cost of solid waste management. Thus, the data that is presented is not complete, but rather is representative of a significant part of the population where solid wastes are originated in the City of Los Angeles.

Among the numerous programs instituted by the Bureau of Sanitation has been the Refuse Sampling Program. The program, which has compiled the percentages of fifteen waste categories in typical solid waste collections, is extremely useful for planning and control of future solid waste management operations.

This data provides us with insight into the changing pattern of solid waste generation -- in terms of compostion, volume, and population shifts.

A Methane Recovery Program recently begun will provide alternative uses for solid waste by products. It is too early to make any judgments on the success or cost savings of the program for the population. If successful, the program could provide an alternative energy source for the population of Los Angeles.

Much of the data available from City and County solid waste management agencies is for internal use in determining costs, life expectancies of landfills and similar operating information. The studies that have been undertaken on such matters as the composition of solid waste have been for investigating recycling possibilities or finding better disposal methods, and the data has only secondary value as an indicator of environmental quality. There has not been much effort to indentify the specific points of origin for the waste brought to disposal sites.

Compounding the problem is the fact that the available statistics on solid waste cover only one-third of all waste disposal activities in the City, and that one-third is made up only of residential users.

Data Survey and Analysis

Until very recently, the city maintained two sanitary landfills, at Toyon Canyon and Sheldon-Orleta. The latter was closed in 1974. Sanitary landfills are the only method of disposal used by the city. In the 1972-73 period, 55.7% of household refuse collected was disposed of in these two landfill sites (See Figure 25). The rest was disposed of at sites operated by the Los Angeles County Sanitation District. Animal carcasses collected are disposed of by delivery to private firms.

Each refuse collection area, of which there are six, shown in Figure 26, has its own crew. There are between 410 and 420 trucks, depending on the season, which collect the refuse. Each truck carries two men on it and can hold 7-8 tons of refuse.

	CITY OPERATION				LOS ANGELES COUNTY SANITATION DISTRICT			OTHER		
Years	Toyon Canyon	Sheldon Arleta	Bishops Canyon	Branford	Palos Verdes	Mission Sopulveda	Cala-basas	School	Private	Total
1968/69	370,710	486,503	430,747	64,098[1]	58,414	265,063	115,920	16,095		1,807,550
1969/70	470,767	434,388	273,622	63,000	56,707	311,614	123,218	17,227		1.750.543
1970/71	697,629	590,336		8,976	56,015	307,488	120,944	21,021		1,802,409
1971/72	665,345	868,150	526	980	56,868	303,471	128,094	24,210		2,047,644
1972/73 .	630,227	685,357			57,850	310,092	129,964	25,383		1.838,873

Includes 50,000 tons of cover material accepted from private sources.

2. Included are approximately 600,000 tons per year from "other city departments".

Source: Adapted from Summary of Activities, Bureau of Sanitation, 1968-70 1969-70; 1970-71; 1971-72; 1972-73, City of Los Angeles

Figure 25. Refuse Disposal - Household refuse by disposal sites - quantities (tons) for 1968-1973.

	Population 1970	%	Total Refuse (tons) Collected 1968/69	1969/70	1970/71	1971/72	1972/73
South Central	564,743	20.1	213,817	210,380	212,049	209.126	202,563
North Central	775,763	27.6	226,553	224,609	226,766	227,113	228,795
Western	355,636	12.6	228,691	224,496	222,233	221,420	221,107
East Valley	560,138	19.9	301,362	262,680	259,687	260,746	250,582
West Valley	405,917	14.4	180,254	215,407	210,681	216,272	221,657
Habor	153,042	5.4	56,243	56,707	56,015	56,868	57,856
Total	2,815,239	100.0	1,206,920	1,194,279	1,187,431	1,191,545	1,182,554

Source: Adapted from Summary of Activities, Bureau of Sanitation, 1968-69; 1969-70; 1970-71; 1971-72; 1972-73.

Figure 26. Total household refuse collected by ton/per area by year 1968-1973.

The Bureau has collected data for a five year period in order to show trends and changes in the nature of solid wastes. In the five year period 1968 to 1973, total tonnage of refuse decreased from 1,215,087 tons to 1,184,830 tons. The population of the areas has also decreased slightly from 2,926,370 to 2,840,013 people (Figure 27).

This decrease in the tonnage of solid waste collected has been interpreted as showing an increase in the amount of plastics in solid wastes, accompanied by a decrease in the amount of metals. In-depth research has not been conducted to explain this phenomenon. The data suggests many alternative possibilities.

Cost--

While the total tonnage of solid waste and the total population of the City have decreased over the five year period, the cost of solid waste collection has increased. The costs have gone from $13,288,551 to $18,908,745, which is a 42% increase over the five year period (See Figure 28). The increase in collection cost and the decrease in tonnage has caused the cost per ton of collection to increase 45% from $11.01 to $15.99.

The disposal costs, while being about 1/10 the collection costs, have also increased 59% during the five year period. The amounts paid by the City to use County and private landfills have also increased 59%. Again, the primary percentage increase in costs at City operated facilities has been in mobile equipment expense, which increased 160%. Disposal costs per ton have gone up 144%. Overall, the total cost per ton, including disposal and collection costs, has increased 51%.

Cost Comparisons by Site--

The Los Angeles County Sanitation Districts operate landfills that are used by the City. A contract price per ton is negotiated, and the only variable is the number of tons. The four landfills used by the City are listed below, with the price per ton and number of tons brought into the landfill for 1972-73:

Site	Tons	Price
Mission Sepulveda	310,092	$1.66
Calabasas	129,964	1.66
Palos Verdes	57,850	2.00
Scholl	25,383	1.55
TOTAL	523,289	

In comparing these figures with the 1972-73 data for Toyon Canyon and Sheldon-Arleta (Figure 28), we find that City operated landfills are less than half the cost per ton of County landfills. The tonnage of household refuse dumped in the County landfills accounts for approximately a

Years	Household Refuse	Commercial	Dead Animals	Total	Population Served	Tons Solid Waste Collected Per Person
1968/69	1,206,920	6,714	1,453	1,215,087	2,926,370	.415
1969/70	1,194,279	5,932	1,701	1,201,912	2,926,370	.411
1970/71	1,187,431	4,725	2,036	1,194,192	2,815,239	.424
1971/72	1,191,545	1,110*	2,430	1,195,084	2,839,564	.421
1972/73	1,182,554	*	2,276	1,184,830	2,840,013	.417

* This collection was contracted out beginning Oct. 1, 1971

Source: Adapted from Summary of Activities, Bureau of Sanitation, 1968-69; 1969-70; 1970-71; 1971-72; 1972-73, City of Los Angeles

Figure 27. Solid waste collected in City of Los Angeles, population, and per capita solid waste by year 1968-1973.

Collection Cost	1968/69	1969/70	1970/71	1971/72	1972/73
Salaries (Collection Crews)	$9,314,887	$10,357,380	$10,800,332	$11,385,592	$12,014,304
Salaries (Supervision & Clerical)	1,134,369	1,260,048	1,409,899	1,517,199	1,757,478
Automated Expense, including Depreciation of Equipment	2,727,783	3,471,862	3,085,549	3,681,132	4,973,628
Other Expense	111,512	121,932	52,107	148,942	163,745
Total	13,288,551	15,211,222	15,347,887	16,732,865	18,908,745
Disposal Cost					
City-Operated Facilities					
Salaries (Field Crews)	247,652	256,562	307,101	333,082	351,749
Salaries (Supervision & Clerical)	50,724	71,523	62,241	73,135	91,926
Mobile Equipment Expense, including Depreciation of Equipment	194,886	151,087	230,015	430,923	506,459
Other Expenses	149,129	50,322	181,063	111,862	72,704
Total	649,391	529,494	780,420	949,002	1,022,838
Non City Facilities					
Disposal Charge (Revenue)	557,424	637,543	788,917	797,358	884,465
Total Cost (Revenue)	1,199,815	1,167,037	1,569,337	1,746,360	1,907,303
Net Cost of Collection and Disposal	$14,488,366	$16,378,259	$16,917,224	$18,479,225	$20,816,048

Figure 28. Summary of household refuse collection and disposal direct costs for the period 1968-1973.

Unit Costs of Collection and Disposal	1968/69	1969/70	1970/71	1971/72	1972/73
Cost per Ton of Collection	11.01	12.74	12.93	14.04	15.99
Cost (Revenue) per Ton of Disposal	.66	.98	1.32	1.47	1.61
Total Cost per Ton	11.67	13.71	14.25	15.51	17.60
Total Cost per Capital	4.95	5.60	6.01	6.51	7.33
Total Cost per Occupied Dwelling Unit	14.46	15.10	15.71	17.81	18.85

Source: Adapted from Summary of Activities, Bureau of Sanitation, 1968-69; 1969-70; 1970-71; 1971-72; 1972-73; 1972-73, City of Los Angeles

Summary of household refuse collection and disposal direct costs for the period 1968-1973.

(Figure 28 continued)

third of all tonnage for 1972-73.

Landfill Sites--
The composition of materials in the landfill is such that there is a lot of settlement and movement. The landfill has the consistency of a jellied mold, and thus no foundation-type structure can be built on it. When new landfill sites are developed, as is being done in Lopez Canyon, planners estimate the life to be 20 years.

The City currently operates only one landfill, at Toyon Canyon in the Griffith Park Area. The landfill at Sheldon-Arleta was filled during 1974. The City is developing a site at Lopez Canyon in the northeast part of the San Fernando Valley, but it will take two years for it to become operational.

The City also makes use of landfills operated by the Los Angeles County Sanitation District. Located in various parts of Los Angeles County, they include Palos Verdes, Mission Sepulveda, Calabasas, and School Canyon.

The private companies who pick up the bins and other commercial refuse make use of private and County Sanitation District landfills. Since data is not available on private collections and disposals, we cannot make any statement about the estimated life time of private landfills or County Sanitation District landfills.

City Refuse Sampling Program--
This program was initiated to describe the composition of household refuse in order to provide planning information to systems designers and operations managers. Planners wanted to know whether it was economic to recycle metals and papers, and operations managers were concerned with the changing composition of solid wastes and population which produces them.

Prior to this study, the City had determined how much refuse could be collected, separated and weighed into the fifteen different categories, and the minimum number of samples required to measure real differences in refuse composition from various areas of the City.

Samples were taken from the two most different areas of the City, the San Fernando Valley and Central City, to determine the minimum number of samples required to ascertain differences in refuse composition.

Three demographic factors, housing type, topography, and income level were located on maps and specifically identified. Housing type was divided into four parts depending on the number of housing units per structure. The topographical definitions used were flat, rolling, hilly, and rugged. Economic units were categorized by the amount of monthly rental on apartments or the valuation of single-family homes. The various categories were weighted for seasonal variations.

The results of the sampling program for 1972 and 1974 are given in Figure 30. It indicates some very significant changes in the composition of household refuse. The percentage of newspaper and miscellaneous paper in the 1972 sample was 36.51, while the corresponding percentage in 1974 was 13.46. One can only speculate at the reasons for this significant change.

Other significant areas of change included the cardboard category, which constituted 3.72% of refuse in 1972, and 10.11% in 1974. In the grass and dirt category, the figures rose sharply from 12.44% in 1972 to 28.77% in 1974.

Methane Recovery Program

Sanitary landfills are subject to anaerobic decomposition which produces a methane gas. The gas can be harmful if not controlled. In order to prevent the seepage of methane gas into populated areas, a system of gas withdrawal wells located at the periphery of the landfill has been developed at Sheldon-Arleta. Since Toyon Canyon is isolated from any residential population, the danger from the methane gas is minimal, and the program has not been instituted there.

The project began in January, 1974, as a joint venture of the Department of Water and Power (DWP), the Department of Public Works , and the Bureau of Sanitation. The gas is pumped to a specially modified 300 horsepower internal combustion engine which drives an electrical generator. The energy is then distributed among DWP customers in residential areas nearby. It is hoped that in the near future, the gas can be pumped directly to a DWP plant and generate the energy there.

Other City Departments--

The Bureau of Street Maintenance and the Department of Recreation and Parks also contribute to Solid Waste Collection and disposal. The Bureau of Street Maintenance cleans up vacant lots besides its street cleaning functions. The Department of Parks and Recreation handles trimmings and trash at parks.

Private Waste Disposal Contractors--

Except for collecting business taxes, the City of Los Angeles does not regulate private garbage disposal contractors. As a result, they have no obligation to report statistics on their operations, and the volume and type of solid waste they handle is not known. The City Department of Environmental Quality estimates that the private contractors handle roughly twice as much solid waste as the Bureau of Sanitation. This includes an unknown proportion of residential waste and virtually all commercial and industrial waste.

		1972[1]		1974[2]	
No.	Item	Mean % of Sample (190 samples)	95% of Confidence Level	Mean % of Sample (188 samples)	95% Confidence Level
1	Cardboard	3.72	±0.28		
	a. corrugated			2.89	±0.27
	b. dry package			2.99	±0.14
	c. other			4.23	±0.23
2	Newspaper	11.29	±0.68	8.90	±0.51
3	Misc Paper	25.22	±1.01	4.56	±0.28
4	Plastic Film	0.95	±0.06	0.90	±0.06
5	Molded Plastics	1.39	±0.08	2.52	±0.12
6	Leather, Rubber	0.49	±0.07	1.38	±0.16
7	Textiles	2.35	±0.22	3.28	±0.32
8	Lumber	2.06	±0.46	6.26	±0.66
9	Tree Trimmings	20.65	±1.58	17.26	±0.73
10	Glass	7.28	±0.41	4.26	±0.27
11	Ceramics, Stones	0.67	±0.23	1.89	±0.48
12	Non Ferrous Metals	0.86	±0.07	2.15	±0.13
13	Ferrous Metals	5.19	±0.22	3.45	±0.15
14	Garbage	5.38	±0.46	4.31	±0.30
15	Grass and Dirt	12.44	±0.99	28.77	±1.34
	Total	99.94		100.00	

Source:

1. Bureau of Sanitation, City of Los Angeles, Refuse Sampling Program, February 7, 1972 through March 6, 1972, p. 5.

2. Department of Public Works, City of Los Angeles, Refuse Composition Data, 1973 -74, p. 1.

Figure 30. Household refuse composition.

The private contractors do not operate in specific territories. Several different contractors may service different users in a single city block, while a single contractor may have customers scattered over a wide area, both inside and outside City or other administrative boundaries.

ENERGY USE

Energy use is difficult to define in nontechincal language. Perhaps this is because energy is invisible. Energy use occurs when something is allowed to degenerate into a less constrained, less complex, less organized condition. The unwinding of a clock spring is a simple example of energy use. The burning of gasoline in a vehicle is a more complex example. Using a boiler in a factory to make process steam which is then dissipated in a production process, is another example.

Environmental Effects

How does energy use relate to environmental concerns? It relates in many ways; they fall into four basic categories. First, energy use can result in the consumption of natural resources. The burning of coal, oil, natural gas, and uranium are examples. In the opinion of the experts, these resources are limited and not renewable. The consumption of these resources within a few generations (at present consumption rates) is a valid concern of urban dwellers. As fuel production declines, as in the case of domestic oil and natural gas, the disruption of urban economic could be significant unless the decline is forseen and counter measures are taken in time.

The second basic category is the impact on the environment of fuel production and transportation and electric power production. Examples are the appearance of oil derricks off the coast, oil spills, ecological change in Alaska, the barren terrain and erosion left by strip mining, the air pollution caused by coal burning power plants, the radiation hazards of nuclear power generation, the effects of power plant waste heat on the local ecology. Of all the categories, this one is probably of least concern to the urban dwellers. In the final analysis, however, it is the metropolitan area energy demand that is responsible for this environmental damage.

The third category is the environmentally damaging side-effects of energy use. We are learning that many of these are susceptible to being held within reasonable bounds. We are in the process of working out how to exercise this control, politically and technically. EQI's are one of the tools to be used in gaining this control. Examples in this category span the gamut of urban environmental problems. Most air pollutants derive from energy use. All the major urban noise problems (except loud talk in thin-walled apartments) involve energy use: aircraft, trucks, railroads, construction equipment, traffic at intersections. The major land use problems can be attributed to the energy using automobile: urban sprawl, inner city decay, inadequate recreational and park facilities, parking problems. Water quality and energy use are related in several ways: increased per capita consumption because of urban sprawl and dishwashers; increasing lead concentration at the bottome of San Pablo Bay; high nitrogen compound concentrations in waste water and irrigation water because of cleansing agents in automatic washers and use of fertilizers. Solid waste is mainly paper, glass, and cans, all of which require large amounts of energy in their manufacture.

The fourth category is energy used to improve the environment. For example, in the Los Angeles basin the importation of water from northern California and the Colorado is a major factor in maintaining the quality of the local ground water. To import this water, however, requires large amounts of energy. In fact, the Metropolitan Water Districts (which imports the water) is said to be the largest single electric power user in the County.

The use of energy in recycling of solid waste and waste water are other examples of this positive impact of energy use on the environment. In these latter cases, it is often true that there is a net energy use reduction because it takes less energy to recylce than to produce a product from virgin materials.

Rationale for Proposed Indices

There are many facets to the subject of energy use. On some facets of the subject, a confusing mass of data exists. On other facets important to fuel supplying organizations, the key data is a closely guarded secret.

Here is a list of some aspects for which indices could be concocted:

Fuel production
Fuel importation
Fuel storage
Electric power generation
Electric power importation
Electric power transmission facilities
Fuel consumption by consumer category
Electricity consumption by category
Fuel production pollutant emission
Fuel storage pollutant emission
Fuel consumption pollutant emission
Power generation pollutant emission
Radiation
Waste heat
Fuel prices
Electricity prices
Cost factors
Fuel substitution possibilities
Solar power usage
Wind power usage

The list is not exhaustive and each line item in the list could be broken into subcategories, along such dimensions as time, space, and technical specifications.

The point is that selectivity is necessary in developing energy use indicies. Any metropolitan computer system could easily be overloaded with unused data on the subject. A set of priorities or definition of goals with respect to energy use is needed as a basis for selectivity.

Reviewing the four categories of energy-use-environmental-effects, a need for improvement is evident in all of them. The present rate of exhaustion of fuel supplies is intolerable. The ecological damage of energy production activities is something nature lovers can never accept. The side-effects of energy use may be a major reason the City of Los Angeles is suffering a population decline. Many would agree that waste recycling and water reclamation need to be done on a much larger scale.

To gain public support for these improvements and to effectively organize and manage the specific improvement programs many types of information are needed. There is much to be done in the way of developing urban energy use information systems.

Only an initial information development program has been formulated in this study. This initial program is aimed at measuring certain major changes in energy use that are needed. Other needed changes are postponed to a later development phase.

Note that indices to measure needed change in energy use are recommended, not simply indicators of the present status of energy use. This requires that energy use goals, or standards, be defined so that indices that measure the difference between actual and desired performance can be developed.

Three major energy use goals will now be defined.

New Sources--
The first goal is to move away from reliance on limited and expensive energy sources. We must begin to value oil and natural gas in the same way as we do wood. These resources are all limited and too valuable to simply burn for the heat that can be produced. The use of solar heating techniques for water and space heating and cooling is one practical way to proceed toward the goal of reliance on low operating cost, dependable energy sources. The capture of solar energy for electric power generating purposes is another technically feasible possibility to be explored. Geothermal energy is a third possibility and there are others.

This first goal is concerned with doing something about the first category of energy use effects on the environment, namely resource depletion. A more short range goal concerned with this same category was considered, but is not included in the initial development program. This is to increase the price elasticity of petroleum products. Work on coal gasification will increase the price elasticity of petroleum as it is successful. The development of car pooling information centers helps to make a quick increase in car pooling feasible whenever an oil embargo against the United States occurs. Development of the oil fields in California should reduce the paralyzing effects of an oil embargo on Los Angeles.

Efficiency--

A second goal should be efficiency in energy use. Much could be done to conserve fuel without reducing the standard of living enjoyed by Los Angeles residents. Here are some examples of inefficiency in energy uses. Better insulation of homes and work places could reduce the natural gas and fuel oil burned for space heating and cooling by more than 30%. The large private automobile is a very inefficient form of transportation, especially when only one commuter is being transported. Industries and commercial transport consume more than half of the energy used in Los Angeles. Much of this fuel and power usage could be reduced.

In some circumstances, the goal of efficiency could lead to increased energy use by the City of Los Angeles. The recovery of metals, cellulose, glass, organic substance and other potentially valuable materials from solid waste may be examples of this. If the energy required for the recycling of solid waste is less than that required for production of the materials from virgin sources, then the energy should be expended on recycling in Los Angeles for the sake of avoiding the use of more energy elsewhere.

Efficiency in energy use can also be promoted by way of efficiency in water use. The largest electric power uses in Los Angeles is the Metropolitan Water District. The power consumed in bringing water from northern California and the Colorado is the equivalent of about 4% of the total electric power consumption in Los Angeles County. Approximately 3 million barrels of fuel oil are required each year to generate the electric power used to import water.

Curb Pollutants--

The third goal in energy use is to control the polluting side effects. A physical system doing work has side effects. For example, a car exhausts pollutants in the process of transporting itself. A furnace exhausts pollutants in the process of heating air or water. Jet engines create noise as well as thrust. An endless variety of illuminated signs can be tiring as well as informative. A freeway system creates urban sprawl while making it possible to get around quickly.

Some progress has been made in controlling the air polluting side effects of motor vehicles, power plants, and industrial fuel consumption. Much more can be done to control these side effects as well as the noise and urban sprawl effects. So far the efforts at controlling the side effects of motor vehicles have been within the confines of burning gasoline in an internal combustion engine. It is becoming clear that the best solution is not within this confine. Control of the pollution from power plants and industrial fuel consumption is no problem technically, although it requires capital investments that may not be made voluntarily.

Proposed Energy Use Indices and their Meanings

A separate energy use index is recommended to measure progress toward each of the three goals for energy use. In each case, the index ins constructed by calculating what has been achieved, or remains to be achieved as a percent of total actual performance.

Inexhaustible Energy Use Index--

This index measures the energy used from virtually inexhaustible sources expressed as a percent of all energy used. At present, this index is virtually zero. The goals is to make it reach 100%.

In addition to an overall index value, subindices can be calculated for specific categories of energy use. Electric power generation and use is one natural category. A currently used, but inadequate, set of energy use categories is as follows:

a) Electric power generation and use
b) Oil refinery fuel usage
c) Other industrial fuel usage
d) Commercial/residential heating and cooling
e) Transportation

The 1973 energy usage of Los Angeles County broken down by these five categories is given in Figure 31. The City could expect to make progress first in increasing the Inexhaustible Energy Use Index (IEUI) for commercial/residential heating. This could be done through the use of solar heating systems. A second category in which the IEUI could be increased is electric power generation and use.

Efficiency Index--

This index measures the extra consumption of limited supply fuels as a percentage of total limited supply fuel consumption. The "extra consumption" is the excess of actual fuel consumption over the fuel that would be needed under efficient usage conditions. The limited supply fuels would include crude oil derived fuels, natural gas, and uranium. The goal, of course, is achieved when the index is zero.

Calculation of the fuel required under efficient usage conditions is a task that remains to be accomplished before a numerical value for this index is available. This calculation can be broken into separable calculations for each energy use category. Each of these calculations would be different.

In the case of electric power generation, the fuel required if all Los Angeles power were generated in the most efficient type of plant would be the answer so far as power generation is concerned. This ideal power plant would employ technology somewhat in advance of that in currently operating plants.

A second aspect of determining fuel required for electric power is estimating the electric power required under efficient use conditions. Actual electric power usage has to be reduced to reflect what demand would be if buildings were properly designed and insulated and only the most efficient type air conditioners were used. Inefficiency in all significant components of electricity usage should be taken into account. The result is likely to be significantly lower level of electric power demand for the case of complete efficiency. The possibilities of shifting the distribution of demand over the 24 hour and 7 day cycles might also be taken into account.

The calculation of oil refinery fuel requirements under conditions of maximum efficiency would be similar to the electric power case in that the fuel requirements of the most efficient possible refinery would be used as a standard.

The fuel required in the "other industrial category" under conditions of efficient usage would have to be calculated for a stratified sample of industrial plants. This result could then be extrapolated to reflect the total fuel requirements by the many thousands of industrial plants in the Los Angeles area.

The fuel required for heating and cooling purposes by residential and commercial users under conditions of ideal efficiency should be significantly less than that currently used. In calculating how much less deficiences in insulation, furnace systems, and gas water heaters, refrigerators, stoves, and dryers should be considered.

The fuel required for transportation purposes under efficient use conditions should be based on the fuel required by the ideal transportation for Los Angeles. The calculation would involve determining the transportation needs of Los Angeles residents and the most efficient way of meeting that need. The fuel required to meet these needs in the most efficient way could then be estimated.

Energy Pollutant Control Index--

This index measures the excessive polluting side-effects of energy use as a percentage of total polluting side effects. The third goal mentioned in the last section will be achieved when this index is zero.

To calculate an excess in a side effect, a standard, or maximum acceptable side effect must be set. The excessive side effect is the difference between the actual side effect and the standard.

What are the polluting side effects of energy use that the City of Los Angeles seeks to reduce? Two types are air pollution and noise. Others exist but are more difficult to measure. For example, the effects of energy use on the undisciplined spreading out of a metropolitan area are much less easily defined. In general, the relation of energy use to land use and misuse is complex because land use has many facets. Raise the price of gasoline and real estate prices will drop on the periphery of a metropolitan area. Also, political support of mass transit will increase. Raise the price of natural gas and multiple dwelling units will gain an additional economic advantage. As the price of certain fuels rise, generally, it would not be surprising if political support for land use planning also increased. So there are definite relations between energy use and land use, but they have not yet been satisfactorily modeled.

To describe the manner in which a side effects control index could be calculated only the air and noise effects will be treated at this time. In the case of air pollution, five categories of air pollution causing substances are commonly recognized. These are nitrogen oxides, sulfur oxides particulates, carbon monoxide and hydrocarbons. The burning of carbon type fuels involves emissions of these five types of substances in a greater or lesser degree depending on the specific fuel, the type of combustion and the measurement techniques.

The Environmental Protection Agency has set specific standards on these emissions for each of the common moving and stationary fuel burning systems. The City of Los Angeles could use these standards or more stringent standard as a basis for calculating Air Pollutant Control Index. This index will show the percent of excess pollutants being emitted into the air as a result of energy use. A preliminary estimate of this index for Los Angeles is 60%, or more. In other words, 60% of the pollutants will be eliminated when 1975 EPA emission standards are in fact achieved. The basis for this figure is given near the end of this section.

In the case of noise pollution, major sources that involve energy use are: aircraft, major roads, stop light intersections, construction work sites, and mass transit systems. To develop an index, three types of data are needed: (1) the noise generated by each particular type of machine, (2) a noise standard for each of these machine types, and (3) volume of usage data by machine type location, and time of day, week, and season of year.

Availability of this data is discussed in the next section. A Noise Pollutant Control Index based on this data would indicate the excess machine created noise.

Index Computation Requirements

The three proposed energy use indices are based on very current perceptions as to what the major metropolitan energy use goals will be for the remainder of this decade. Needless to say, the data collection systems of Los Angeles area governments have not yet evolved to the point of supporting the computation of these indices. So this section will focus on the enhancements to the database needed to generate energy use index values.

In the past, the main energy use goal has been to control air pollutant emissions in Los Angeles County, and the entire south coast air basin. The database to support this goal is maintained by the APCD and is well developed. This same data base can serve as the nucleus of the database needed to support progress in solving a broader set of energy use problems.

All three of the proposed energy use indices require data on fuel and power consumption. A description of the data available on this will therefore be given first. Problems in disaggregating this data will be discussed. Then the additional data needed to calculate each of the three indices will be described.

Fuel and Power Consumption Data--

Four types of fuel are used in the Los Angeles area. There seems to be only one source of data on each. The Los Angeles APCD has a comprehensive set of these data on County energy use. No comprehensive source on City fuel consumption was found. A review of the County data will clarify the type of information that is available and what remains to be done to develop comprehensive City data.

The APCD uses a two-way breakdown of energy use. One breakdown is by type of fuel burned and the other is by five groups of fuel burning systems: power plants, refineries, other industrial, commercial/residential gas heating, and transportation systems.

Figure 31 displays aggregate APCD fuel usage data for 1973, 1968, and 1964. The unit of measure used by the APCD is a barrel of fuel oil containing 6.3 million British Thermal Units (BTU). This energy value is proper for the most common fuel oil. It is larger than the average value for gasoline (5.25 BTU per barrel) or diesel oil (5.83 BTU per barrel).

Figure 31 gives an overview of energy use patterns in Los Angeles County. No coal is used. This exhibit shows a total Los Angeles County fuel use in 1973 of 223.4 million barrels. This is up from 165.1 million barrels

FUEL USE CATEGORIES		FUEL OIL	GAS	GASOLINE DIESEL	TOTAL EQUIVALENT BARRELS/YEAR	% OF TOTAL
Power Plants	1973	42.1	17.9		60.0	27
	1968	9.5	47.6		57.1	29
	1964	7.8	27.0		34.8	21
Oil Refineries	1973	1.8	27.9		29.7	13
	1968	0.6	27.2		27.8	14
	1964	1.5	23.8		25.3	15
Other Industrials	1973	0.7	14.6		15.3	7
	1968	0.4	13.5		13.9	7
	1964	0.2	12.1		12.3	7
Commercial/ Residential	1973		50.5		50.5	23
	1968		43.7		43.7	22
	1964		40.9		40.9	25
Transportation	1973			67.9	67.9	30
	1968			58.8	58.8	29
	1964			51.8	51.8	31
Total	1973	44.6	110.9	67.9	223.4	100
	1968	10.5	132.0	58.8	201.3	100
		9.5	103.8	51.8	165.1	100
% of Grand Total	1973	20.0	49.7	30.3	100.0	
	1968	5.0	66.0	29.0	100.0	
	1964	5.8	62.8	31.4	100.0	

*6,300,000 BTU/barrel

Figure 31. Los Angeles County fuel usage (Millions of barrels per year*)

ten years earlier. The average annual rate of increase for the period is approximately 3%.

The most dramatic change in the decade is the switch from natural gas to fuel oil for power plant operation. This has occured since 1968. This has had a negative effect on air quality as will be explained later on. We can also see from this figure that growth in all categories of energy is not uniform. Fuel consumption for electric power generation grew more rapidly during the 1964-1968 period than later. Transportation usage is growing at an above average rate. Commercial/residential heating is growing at about the overall average rate. Industrial and refinery usage is growing slower than average.

Specific points concerning the source and meaning of data in Figure 31 are as follows:

Power plants-- This information comes from reports submitted to APCD by 10 power plants in the county. Two Southern California Edison plants (Huntington and Etiwanda) are excluded although they certainly contribute to Los Angeles smog.

In the 1960's, it was common practice to burn mainly natural gas from May to November because this resulted in less pollutants during the season of greatest smog danger. With the switch to a much larger reliance on fuel oil in the 1970's, it is no longer possible to follow the previous pattern. We were told the APCD has discontinued keeping specific records on proportions of fuel oil and natural gas burned by power plants in the May to November period.

The small increase from 1968 to 1973 of 2.9 million barrels in fuel consumption by power plants, compared to 22.3 million barrels in the previous 5 years, is accounted for by a rapid rise in imported electric power during the 1969-71 period. Figure 32 shows a 10 year history on electric power usage. Imported power amounted to approximately 15 billion KWH in 1973, compared to 4 billion in 1968. It would take approximately 17 million barrels of oil to generate the difference of 11 billion KWH of electricity-- 1 barrel generates 667 KWH. Add the 2.9 to the 17 and the result is an approximately 20 million barrel increase in the five years since 1968 compared to a 22 million barrel increase in the five years ending in 1968. This suggests some slowing in the power consumption growth rate, but not much.

It should be noted that the figures in Figure 32 do not include the power required to bring water to Los Angeles from the Colorado river and the Sacramento Delta. Approximately 2 billion KWH are required annually for this importation of water.

	GENERATED IN COUNTY	TOTAL ENERGY USED
1964	22,687	26,300
1965	25,598	30,600
1966	31,548	35,800
1967	31,828	36,600
1968	34,926	39,300
1969	35,091	42,300
1970	36,414	46,000
1971	34,272	49,500
1972	36,540	50,040
1973	38,367	53,600

SOURCE: APCD

Figure 32. Los Angeles County Electric Energy
Millions of Kilowatt--Hours

Electric Power consumption in 1973 is double that of 1964. If power consumption doubles again in the next ten years, we can expect the increased power to be imported to the Los Angeles area. So the main Los Angeles environmental problem as far as electric generation is concerned is the shift from natural gas to fuel oil at the power plants within the county. Not only is this shift likely to continue but unless large investments are made at all refineries and/or power plants the burning of the fuel oil is likely to produce increasing amounts of sulfur.

Oil refineries-- This information comes from reports submitted to APCD by refineries in the County. The gas used in oil refinery operations includes both natural gas and various types of refinery gas generated by the refining process. In 1968, for example, APCD figures indicate more than half of the gas burned was refinery made gas.

Other industrial-- Fuel oil usage in this category is based on a statistical sample. In recent years, it has been based on reports to the APCD of fuel oil usage from 150 industrial plants in Los Angeles County. This sample is currently being expanded to include all plants in Los Angeles County that may be creating more than 50 tons of pollutants per year.

Natural gas usage in this category is total deliveries to interruptible customers as reported by Southern California Gas Company.

Commercial/residential-- This is the natural gas deliveries to noninterruptible customers as reported by the Southern California Gas Company.

Transportation-- We have been unable to locate a direct report on gasoline and diesel sales or usage in Los Angeles. The figures shown in Exhibit 31 are based on total state gasoline sales as reported to the California Franchise Tax Board. A percentage of this state total is shown. It is the percent of all registered vehicles in the state that show an address in Los Angeles County.

Fuel oil-- It should be noted that there are many grades of fuel oil. Two major categories are residual and distilled fuel oils. Within each of these an important distinction between grades is the sulphur content of the grade. According to the APCD Rule 62, fuel oil having a sulphur content in excess of 0.5 percent by weight may be burned in the County only on a special exception basis. More detailed information on the sulphur content of fuel oil burned may be available from the APCD.

Gas-- All fuel in this column is natural gas except for the refinery made gas noted above. The natural gas is assumed to contain 6.3 million BTU per cubic foot.

The type of data shown in Figure 31 has been obtained for each of the years from 1964 to 1973 inclusive, and is included in the Community Analysis Bureau data base. In the future, this information can be obtained annually from the APCD.

Disaggregating APCD Data

The City of Los Angeles requires the details of the APCD data as much or more than it needs County totals. Ideally, CAB would like energy use data by councilmanic district. The following possibilities and problems in getting the details were noted in this investigation.

The City's Department of Water and Power should be able to provide data on city electricity generation importation, and consumption. Fuel used in city power plants should be available from either APCD or the Department of Water and Power.

Oil refinery fuel consumption is available at the APCD by individual refinery so that the energy use of refineries in the City is obtainable.

Obtaining detailed industry fuel consumption data is difficult because the APCD figures are based on a county-wide sample. If estimates of the percent of county industrial activity in each councilmanic district were available these might be used to breakdown the total county industrial usage.

There is an apparent problem in obtaining data on the usage of natural gas under noninterruptible contracts with the City. The Southern California Gas Company is reportedly unable to provide this information. Direct discussions with the Company on this problem have not been held. Such discussions might identify a reasonable basis for estimating this natural gas consumption.

The data on gasoline and diesel consumption in the City of Los Angeles is not directly available. The California Air Resources Board, which has responsibility for motor vehicle pollution, works with total state gasoline sales as reported to the Board of Equalization. They estimate motor vehicle fuel consumption in the South Coast Basin by using the proportion of total State vehicle registrations that have South Coast Basin addresses. The local APCD does the same. One problem is that vehicle registration data is not freely available on a City basis. Registrations by Zip Code is available from private companies who have purchased the data on a Statewide basis from the Department of Motor Vehicles. One such company is the Reuben H. Donnelly Corporation. This company has offered to sell the registration information for $5.00 per Zip Code. Using this registration information it is possible to estimate the vehicle fuel consumption by Zip Code area within the City and for the City as a whole.

Additional Data for Unlimited Energy Use Index--
Data must be collected on the amount of power generated and cooling provided by burning solid waste, solar heat collection, wind conversions, and similar systems. Power supplied by breeder reactors could be included in this category.

With this additional data computation of the unlimited energy use as a percent of total energy used is possible. Both an overall index and subindices for various use categories could be calculated.

Additional Data for Efficiency Index--
To calculate the excess hydrocarbon fuel consumed in producing electricity and the excesses in consumption of fuel and electricity, standards of efficiency have to be set. This has already been discussed in connection with the definition of this index.

Data on the number of machines in various categories (cars, trucks, motorcycles, air conditioners, freezers, heaters, ovens, and so forth) would also be needed. By simulating the operation of these machines under efficient conditions, the ideal energy use can be determined and the efficiency index calculated.

Additional Data for Energy Pollutant Control Index--
Basically, the data needed to calculate this index for air pollutants is available at the APCD. The data to calculate it for noise pollution is available so far as aircraft and freeway traffic noise is concerned. Data on noise generated by such sources as boulevard stops, construction work, and bus service is lacking.

Calculation of the energy pollutant control for air pollution will now be covered in detail. Smog is made from nitrogen oxides, hydro-carbons, sulfur oxides, particulates, and carbon monoxide. These are given off in burning hydrocarbon fuels. They interact in the atmosphere to form ozone, nitric acid, sulfuric acid, and possibly other irritating and corrosive compounds. The chemical reactions that take place in the atmosphere filled with the five smog-creating compounds are not completely understood.

To monitor the emissions of these five compounds, it is necessary to estimate the amount of the compounds released in various fuel burning processes. The amount released per unit of fuel burned are called pollutant emission factors. When an emission factor is multiplied by the volume of fuel consumed during a certain time period, the resulting product is an estimate of the amount of the polluting compounds released into the atmosphere during the time period.

Emission factors are estimated by measuring the amounts of the five compounds that are given off by a burning process. Different fuels have different emission factors. Different types of furnaces, boilers, and combustion engines result in more or less emissions. Technical differences in the way the emissions are measured can also lead to a difference in estimates.

Some emission factors gathered from various sources are shown in Figure 34. For electric power plants, factors are shown that were derived from APCD reports entitled, "Power Plant Fuel and Emissions--Los Angeles County. These reflect actual performance in 1973 in this County. They can be compared to the EPA estimates of emission from uncontrolled burning and to the EPA control standards for power plants. The comparison shows that Los Angeles power plants as a group have not yet met the national standard for hydrocarbon emissions, but produce only 80% of the allowed nitorgen oxides and 50% of the allowed sulfur oxides and particulates.

The emission factors for combustion engines in the figure are derived from South Coast Air Basin data obtained from the California Air Resources Board. Comparison of these combustion engine factors to the power plant factors reveals the role each plays in smog generation. Carbon monoxides, hydrocarbons, and nitrogen oxide emission are much larger for combustion engines than for power plants. Both emit roughly the same amounts of particulates. Sulfur oxides are mainly created by burning heavier fuel oils in power plants.

Total 1973 emissions in Los Angeles County are estimated in Figure 35 . The figures in this exhibit are based on: 1) fuel consumption in Figure 31, 2) the emission factors in Figure 34 , and 3) additional APCD information on oil refinery and other industrial emissions. The additional APCD information consists of estimates of major stationary point source emissions issued in April and September of 1973. Basically, Figure 35 shows the result of multiplying the fuel consumption volumes of Figure 31 by appropriate emission factors to obtain estimates of total emissions in 1973.

The specific emission factors used in developing Figure 35 are shown in Figure 33 . The asterisks in this latter exhibit denote factors that are not wholly dependent on the burning of a particular fuel. They include total emissions from oil refining and other industrial processes.

Figure 35 shows total emission of 4,272,100,000 pounds for the year. Sixty-three percent of this was carbon monoxide, virtually all of it emitted by motor vehicles. The next largest component is nitrogen oxides which amounted to 17%. Most of this (74%) comes from motor vehicle emissions. In total, motor vehicle emissions account for 88% of total emissions not connected to combustion engines in a significant way are the sulfur oxides. Approximately half of all sulfur oxides in the Los Angeles atmosphere come from electric power generation.

The Air Pollutant Control Index is defined as excess emission as a percent of total emissions. Figure 35 gives total emissions. How much of this is excess?

(Pounds per Equivalent Barrel)

Fuel Use Category	Pollutant	Fuel Oil	Gas	Gasoline/Diesel
Power Plants	NO	1.55	1.0	
	SO	2.8	---	
	Part.	.3	.015	
	CO	.05	---	
	Organic	.11	0.053	
Oil Refineries	NO	1.55	1.0	
	SO	1.78*	1.78*	
	Part.	0.134*	0.134*	
	CO	0.095*	0.095*	
	Organic	0.218*	0.0218*	
Other Industrial	NO	2.0	1.0	
	SO	4.06*	4.06*	
	Part.	1.49*	1.49*	
	CO	0.216*	0.216*	
	Organic	2.49*	2.49*	
Commercial/ Residential	NO		1.1	
	SO		---	
	Part.		0.04	
	CO		---	
	Organic		0.08	
Transportation	NO			7.72
	SO			0.280
	Part.			0.678
	CO			39.50
	Organic			7.15

*Estimated from APCD reports on total emissions of major point sources.

Figure 33. Pollutant emission factors.

Pounds per Barrel*

	Nitrogen Oxides	Sulfur Oxides	Particulates	Carbon Monoxide	Hydro-Carbons
Power Plants					
Natural Gas					
APCD	1.00	---	0.015	---	0.053
EPA Uncontrolled**	3.58	.004	0.088	.006	0.100
EPA Control Std.**	1.26	---	---	---	---
Fuel Oil					
APCD	1.55	2.8	0.300	---	0.11
EPA Uncontrolled**	4.41	3.3	0.315	.126	.081
EPA Control Std.**	1.89	5.0	0.630	---	---
Combustion Engines					
1973 Domestic Car	4.40	0.183	0.735	15.30	2.385
1968 Domestic Car	9.55	0.183	0.753	47.50	8.900
1973 Heavy gas truck	8.65	0.216	0.753	63.50	7.53
1968 Heavy gas truck	8.65	0.216	0.708	79.30	11.94
1977 Heavy diesel	14.80	1.245	0.552	5.52	1.38
1968 Heavy diesel	18.80	1.21	0.598	6.92	1.35
Motorcycles	1.33	0.111	0.249	184.0	21.50

* A barrel containing 6,300,000 BTU

** Compilation of Air Pollutant Emission Factors, Second Edition, U.S. Environmental Protection Agency; AP -- 42, April 1973

Figure 34. Variations in emission factors.

(millions of lbs/yr)

CONSUMER TYPE	POLLUTANT	FUEL OIL	GAS	GASOLINE/ DIESEL	TOTAL	% OF GRAND
POWER PLANTS	Total	199.2	19.1		218.3	.5
	NO_x	65.0	17.9		82.9	12
	SO_2	117.0	---		117.0	47
	Part.	12.6	0.3		12.9	15
	CO	---	---		---	--
	Organic	4.6	0.9		5.5	1
OIL REFINERIES	Total	6.8	90.2		97.0	2
	NO_x	2.8	27.9		30.7	4
	SO_2	3.2	49.8		53.0	21
	Part.	.2	3.8		4.0	5
	CO	.2	2.6		2.8	--
	Organic	.4	6.1		6.5	1
OTHER INDUSTRIES	Total	6.7	135.9		142.6	3
	NO_x	1.4	14.6		16.0	2
	SO_2	2.5	59.5		62.0	25
	Part.	1.0	21.8		22.8	26
	CO	0.1	3.2		3.3	--
	Organic	1.7	36.8		38.5	7
COMMERCIAL/ RESIDENTIAL	Total		61.0		61.0	2
	NO_x		55.0		55.0	8
	SO_2		---		---	--
	Part.		2.0		2.0	2
	CO		---		---	--
	Organic		4.0		4.0	1
TRANSPORTATION	Total			3753.2	3753.2	88
	NO_x			524.0	524.0	74
	SO_2			19.2	19.2	7
	Part.			46.0	46.0	52
	CO			2680.0	2680.0	100
	Organic			484.0	484.0	90
TOTALS	Total	212.7	306.2	3753.2	4272.1	100
	NO_x	69.2	115.4	524.0	708.6	17
	SO_2	122.7	109.3	19.2	251.2	6
	Part.	13.8	27.9	46.0	87.7	2
	CO	.3	5.8	2680.0	2686.1	63
	Organic	6.7	47.8	484.0	538.5	12
PERCENTAGES	Total	5	7	88	100	
	NO_x	10	16	74	100	
	SO_2	49	44	7	100	
	Part.	16	32	52	100	
	CO	--	--	100	100	
	Organic	1	9	90	100	

Figure 35. Estimated Los Angeles County pollutant emissions - 1973.

The definition of "excess" can be a rather complicated matter, especially for stationary sources. In the case of moving sources, much work has been done on what constitutes a reasonable standard. These results could be adopted by the City.

Fortunately, it is the moving sources that cause most of the emissions. Figure 35 shows this. Therefore, using the State Air Resources Board standards for motor vehicles, it is possible to estimate approximately what the current value of the Air Pollutant Control Index would turn out to be. The ARB standard on 1975 passenger cars is 9 grams per mile of carbon monoxide and 2 grams per mile of oxides of nitrogen. Converting these to the units of Figure 33 yields standards of 11 pounds per barrel for carbon monoxides and approximately 2.45 pounds for oxides of nitrogen. In Figure 33 the 1973 emissions amounted to 39.5 pounds per barrel for carbon monoxide and 7.72 pounds for oxides of nitrogen.

This suggests that the excess emissions of carbon monoxide amounted to 28.5 pounds per barrel or 73%, and the excess emission of nitrogen oxide amounted to 5.27 pounds or 68% of the total.

The conclusion is that the Air Pollution Effects Control Index will turn out to be at least 60%. In other words, 60% of the emission from fuel consumption in Los Angeles are excess of what they should be. This conclusion is based on the large role carbon monoxide plays as shown in Figure 35 plus some rough estimates of the excess emission of oxides of nitrogen, hydrocarbons, and sulphur dioxide.

SECTION V

DATABASE DEVELOPMENT IN LOS ANGELES

INTRODUCTION

This project has functioned in the somewhat turbulent confluence of two major developments. One, which has been discussed in the previous sections, is the development of better environmental information. The other is development in the data processing industry of systems that are more management information oriented.

Actually, these two trends reinforce one another and will enable us to have a better environment in the long run. Within the context of a single, short-term project, however, they have been like two horses unfamiliar with the ways of working together when hitched to a single load.

In this section the past progress of the Community Analysis Bureau (CAB) is first described in developing an information system that is useful to City government officials in policy formulation and decision-making. This is followed by a discussion of the proliferation of uncoordinated, inadequate, multi-purpose data sources this project team discovered in the process of adding an environmental dimension to the CAB database. The section concludes with some observations on the best possibilities for improving the environmental information available to local government and citizens.

BACKGROUND ON THE LOS ANGELES COMMUNITY ANALYSIS BUREAU

The Community Analysis Bureau (CAB) was founded in 1967 under joint funding from the City of Los Angeles and the Department of Housing and Urban Development. The purpose of the Bureau was to detect areas of blight and obsolescence and to propose programs to cure existing blight or prevent threatened blight.

The years 1967 and 1968 saw the initial staffing and the beginnings of systems design. By 1969, the outlines of the CAB "system" had been completed. During that year the primary activities were data gathering, including the 1960 Census statistics as well as local police, fire, health, education and assessment files.

First Report

In 1970, these files were all gathered for the base year of 1968. The first State of the City report was prepared. This report was generated using a matrix of twenty data items (see Figure 36) for sixty-five geographical areas. The data items included measures of public safety, education, housing and income. The report, "A Strategy for City Survival", stratified each of the sixty-five areas into "blighted", "endangered" or "safe" categories and evaluated the problems in the public service systems.

Second Report

By 1971 data was collected, where available, back to the year 1966 and a much larger group of social indicators was developed. Thus, in 1972, when the second State of the City report was produced, the list of variables in the matrix was expanded to ninety-three and included items concerning health, accessibility, and recreation as well as the subjects previously covered. In this three-volume analysis a series of statistical tools was used including regression, cluster, discriminate, factor, canonical, and correlation analysis. The data was stratified using these analytical techniques and the sixty-five geographical areas were then classified in terms of the composite variables.

A critical analysis of both the 1970 and the 1972 studies identified three primary shortcomings:

1) The level of geographical aggregation had not been satisfactory. In an area such as Hollywood, which is quite large (9,293 acres) and diverse in population, the use of a descriptive indicator that is an average did not permit identification of the pocket conditions.

2) Additional new descriptive variables from the fourth count of the 1970 Census had not been included. This data, which included income, education and employment characteristics, had not been available until after the release of the 1972 report.

3) The statistical tools had been applied only to the variable analysis (data items in the matrix) and had not yet been used to evaluate geographical units (the other dimension of the matrix).

1. Malicious False Alarms per 100 Population
2. Felonies per 100 Population
3. Engine Companies per 1000 Acres
4. Police Costs per Acre
5. Structural Fires per 100 Structures
6. Dropout Rate
7. Percent Minority Enrollment
8. Percent Voter Participation
9. Classroom Instruction Costs per Average Daily Attendance
10. Mean Tenth Grade Reading Achievement
11. Percent Renter Occupancy
12. High School Transiency Rate
13. Percent Public Housing
14. Median Household Rent
15. Percent Sound Housing
16. Percent White Collar Employment
17. Percent Families with Two Bread-winners
18. Percentage Effect of Discrimination on Income
19. Unemployment Rate
20. Median Household Income

Figure 36. 1970 State of the City Database.

1973 Database

For these reasons, the Community Analysis Bureau developed the 1973 State of the City database, with the 1970 census tract as the primary geographical aggregation unit. This database was to be used for interpretation and statistical analysis for the 1973 State of the City Report. It also provided easy access to a comprehensive Citywide database for all users in City government.

The first step in the preparation of this database was to determine what information files were available with a census tract indicator. At the Community Analysis Bureau these included the 1970 Assessor's Local Roll File, the Dun and Bradstreet Business File, the Los Angeles County Heath Department's Birth and Death Files, and the 1970 Census Tapes, first, second, and fourth counts.

Information was also needed from other computer files which did not have a census tract indicator. These included education data from the Los Angeles City Schools, and fire, police and recreation and park statistics. To use this data, estimation routines were developed to transfer the data from one geographical unit (i.e., a school boundary or police reporting district) to the desired census tract unit.

These estimation routines ranged in complexity from simple proportional allocations to computer algorithms. The most complex allocation was the development of the digital character database, which uses SYMAP coordinates to define areas.

The combination of these diverse computer files provided a significant variety of data items. Knowledge gained from both the 1970 and 1972 State of the City reports was used to select the most significant variables. The data items were also chosen in light of the many new statistics that became available in the 1970 Census.

Over 220 data items were selected from the computer files available to provide the nucleus of the City Database. Each of these 220 data items was collected for all 750 City census tracts onto one computer file called SUMFILE. These raw data items are also known as SUM variables.

The evaluation and statistical analysis of the relative characteristics of census tracts require that the data be comparable from one area to another, and for this reason the raw data items alone are not satisfactory. A more comparative form for the data is percentages. Each data item was examined and the more important percentages were defined and calculated. This created over 200 additional data items for each census tract, which were collected on a computer file called SOCFILE.

The percentage data items are also known as SOC variables and have been listed in Appendix C.

One additional computer file was created, called GEOCODE. This file describes where each census tract is located with regard to several other geographical areas. These include, among others, councilmanic districts, planning areas, and statistical areas. This enables the user to define all census tracts that are within one councilmanic district. Only whole census tracts were allocated to each area. All of the geographic areas are listed by their variable names in Appendix C.

This process has created three computer files, GEOCODE, SUMFILE, and SOCFILE, each with data on every census tract in the City of Los Angeles. Because of the usefulness of this data, not only to CAB but all City departments, it has all been organized in an on-line system at the City's Data Service Bureau. This system is called DATABASE. This on-line capability simplifies the comupter programming operations necessary to retrieve the desired information, and it also provides the opportunity to obtain the quickest possible turnaround on data requests. Figure 37 depicts DATABASE.

1974 State of the City Analysis

The 1974 State of the City Analysis has provided a classification of the City which has subdivided the 465-square mile area into 30 components. These components have been called "clusters" because they were derived through the statistical method of cluster analysis.

The first step in preparing the State of the City analysis involved identifying the data items that would be available to describe the City. Urban analysts from the Los Angeles Community Analysis Bureau, the City Demonstration Agency and the Planning Department selected sixty-six variables from the total database which would be used in the cluster analysis.

These variables describing each census tract in the City were then fed into the clustering process. The purpose for clustering the City's census tracts was to combine those areas that have the most similar characteristics. Parts of each cluster may be located in several different geographical portions of the City, but the statistical technique shows that each part of the cluster is more similar to other, distant parts of the cluster than to an adjacent geographical area.

This subdivision into similar components simplifies the process of description which is necessary in the City's policy formulation. One cluster can contain several geographically dispersed subareas, each of

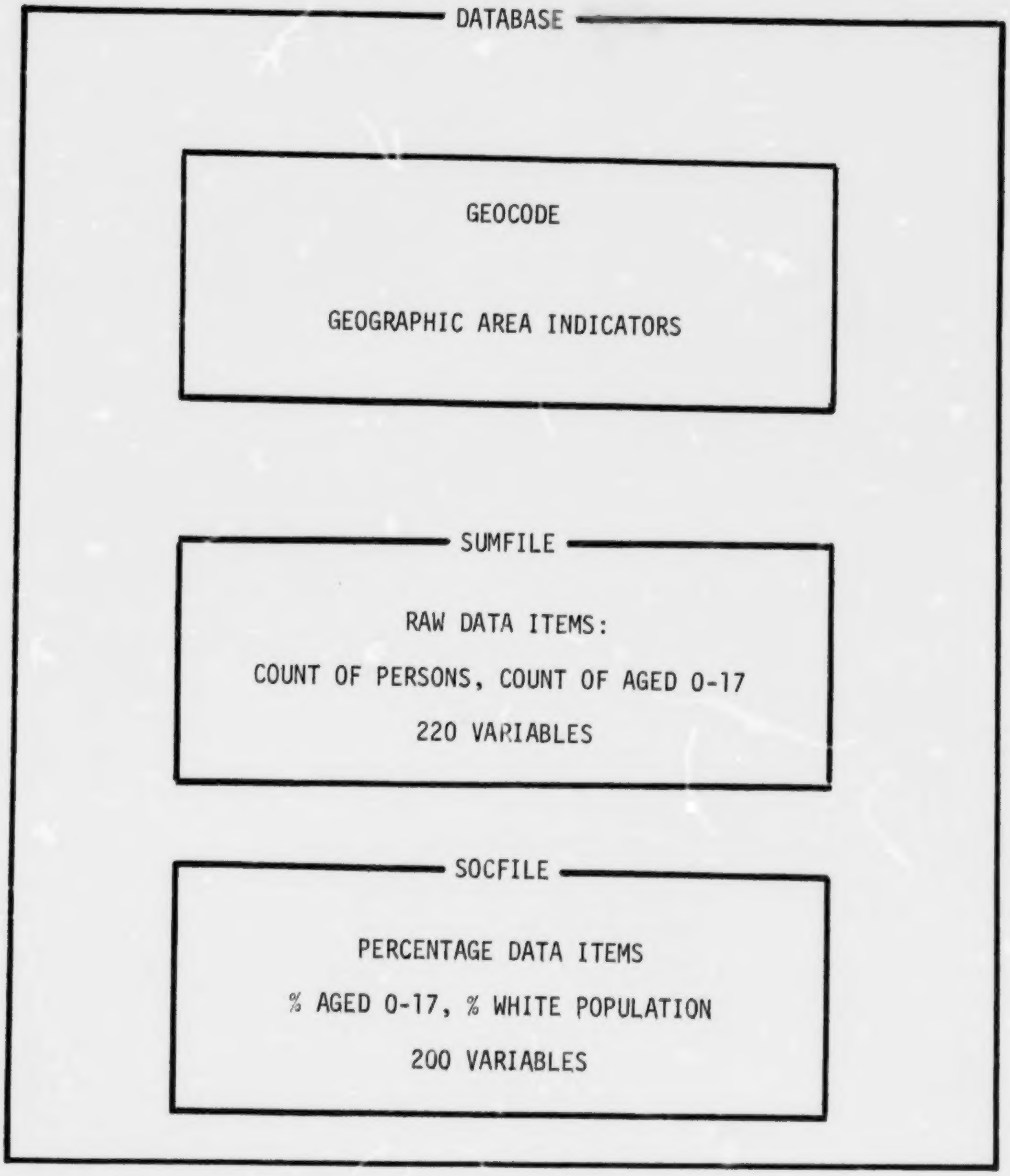

DATABASE
GEOCODE
GEOGRAPHIC AREA INDICATORS
SUMFILE
RAW DATA ITEMS:
COUNT OF PERSONS, COUNT OF AGED 0-17
220 VARIABLES
SOCFILE
PERCENTAGE DATA ITEMS
% AGED 0-17, % WHITE POPULATION
200 VARIABLES

Figure 37. Community Analysis Bureau Data System

which has similar characteristics. If one characteristic can be defined as a problem for one part of a cluster, then the same program recommendations can be made for other parts of the cluster. The clustering procedure produced thirty clusters of similar census tracts within the City. A mapping of each cluster and its census tract components was prepared. Unfortunately, publication difficulties prevented inclusion of the map in this report.

This most recent report of the Community Analysis Bureau, although a significant improvement over the earlier reports, retained two basic shortcomings. It covered only the City of Los Angeles, leaving gaps in the geographical layout where other cities exist, and it had only one strict environmental parameter, the rating attained from Color Infrred photos. For these reasons the Community Analysis Bureau joined with California State University at Los Angeles to improve the matrix-oriented urban analysis with more attention to environmental characteristics.

ENVIRONMENTAL DATA SOURCES

Introduction

Environmental data on Los Angeles has almost as much variety as the people of the area. Air pollution and noise, for example, are both very local and variable phenomena. There is much data on ambient air quality at a few locations. There is little data on ambient noise. The data on point sources of air pollutants is of limited use because a major point source is vehicles and the distribution of point source pollutants is not well understood anyway. Data on point sources of noise and the propagation of that noise is available and the major source of noise information; however, noises are so local and transient that it is not yet possible to obtain a comprehensive yet reliable noise index by census tract.

The data availability situation with respect to water, land use, solid waste and energy is likewise different and peculiar. Each case is a separate story. In the following paragraphs these separate stories are told.

Air

Responsibility for standards and control for all mobile sources of air pollution is vested in the state government and is exercised by the Air Resources Board (ARB). The responsibility for stationary sources of air pollution is vested in the local Air Pollution Control Districts, which are an integral part of the county governments, coordinated to some extent by the State of California Air Resources Board (ARB). The City is left with control of dust, new construction sites, zoning decisions, general land use, transportation corridors, in-town parking and a few other factors that have a tangible impact on air quality.

Data Sources--
The choice of data source is extremely limited. Data comes either directly from the Air Pollution Control District (APCD) or from the quarterly publication of the State of California Air Resources Board (ARB). The ARB obtains its data from the local air pollution control districts, but it is assembled with a certain amount of processing already accomplished by the local APCD's.

The data elements that are monitored by the Los Angeles APCD are shown in Figure 38. These readings are available for all 15 stations in the county, and the values stored are the hourly average of each parameter. A summary of these readings is also available in the State Air Resources Board quarterly publication.

The recent discovery of differences between the monitoring techniques used by the Los Angeles APCD and those used by the rest of the country is not significant for the purposes of this study. For this purpose it is less important that the data be consistent with other parts of the state or the nation, so long as it is consistent with those stations that are used to describe air quality in the City.

Until such time as a correction factor is agreed upon between the agencies concerned, however, we regret that the air quality statements here cannot be compared with other cities that may also be using the same index methodology used in this report.

The single most important use that is made of the air quality data is the notice that it gives of an impending crisis, which triggers a "Smog Alert" that will cause a reduction in buring and physical activities that are dangerous to children and older people during periods of high ambient O_x or SO_2.

An air quality ambient reading is a sample of a particular location's air at the time the sample was taken. Wind direction, wind speed and other factors make it difficult to guess how many yards or even the number of feet away from the monitoring station one must travel before there is a change in air quality, and this change may be for the better or for the worse. To cope with the problem of changing wind direction and wind speed, the evaluations made here are based on annual and seasonal averages in which a number of different climatological conditions is blended, and the resulting values then reflect the wind and weather variables that dominated the period from which the data was taken.

There are approximately 1400 census tracts in the County of Los Angeles,

Hydrocarbons Minus Methane / Hourly Averages
Ozone by KI / Hourly Average / in PPHM
10 x (NO+NO2) / Hydrocarbons - Methane) / Hourly Averages
Carbon Monoxide / Hourly Average / in PPM
Carbon Dioxide / Hourly Average / in PPHT
Sulfur Dioxide / Hourly Average / in PPHM
Sulfur Trioxide / Hourly Average / in PPB
Sulfur Dioxide from SO3 Recorder / Hourly Average / in PPHM
Nitrogen Dioxide / Hourly Average / in PPHM
Nitric Oxide - Direct Readout of NO / Hourly Average / in PPHM
Nitrogen Dioxide / Instantaneous at Half Hour / PPHM
Nitric Oxide - NO + NO2 minus NO2 / Hourly Average / in PPHM
NO + NO2 - Direct Readout of NO = NO2 / Hourly Average / PPHM
NO + NO2 - Sum of NO and NO2 / Hourly Average / PPHM
Hydrocarbons, as Hexane / Hourly Average / in PPHM
Hydrocarbons, as Methane / Hourly Average / in PPM
Methane / Hourly Average / in PPM
Ozone - Rubber Cracking / Average Sample / in PPHM
Ozone Monitor / Hourly Average / in PPHM
Ozone - Photometer / Average Sample / in PPHM
Oxidant by comparable precursor Inst. / Hourly Average / PPHM
Precursor Oxidant / Hourly Average / in PPHM
Particulate Matter - Recorder / Hourly Average / KM Unit x 10
Particulate Matter - Non Recorder / Hourly Average / KM Units x 10
Particulate Matter - Recorder / Hourly Average / COH Units x 10
Ether - Soluble Aerosols / Hourly Average / Micrograms Per Cum
Aldehydes / Hourly Average / in PPHM
Temperature / At Hour / in Degrees Fahrenheit
Relative Humidity/At Hour/ in Percent
Solar Radiation / Gram Calories per Square CM Per Hour
Visibility / at Hour / in Miles x 10
Eye Irritation - Individual / Hourly Maximum / 3 Degree Scale
Eye Irritation / At Hour / Percent of Panel
Temperature / At Half Hour / in Degrees Fahrenheit
Relative Humidity / at Half Hour / in Percent
Visibility / at Half Hour / in Miles x 10

Figure 38. Contents of Master File - Los Angeles APCD Air Pollutant & Weather Data, by Monitoring Station.

but air quality is monitored at only 14 locations. There are about 720 census tracts in the City of Los Angeles, but there are only 3 monitoring stations in this approximately 465 square mile area. When it is noted that air currents make it difficult to extrapolate data from the monitoring station to another point just a few blocks away, the complexities of attribution or distribution of 3 sets of observations to a 465 square mile area can be appreciated.

Noise

Introduction--

Noise is a non-persistent, sometimes elusive pollutant, the effects of which are limited to relatively short distances. This study includes indices of both intrusive and ambient noise, but we must state at the outset that data on intrusive noise is much more complete than the samples used to make a City-wide assessment of ambient noise.

Noise Agencies--

City agencies with concern or general responsibility for noise measurement are:

1) Department of Airports
Monitors airport noise especially at Los Angeles International.

2) Building and Safety Department
Monitors noise levels as part of enforcement procedure for industrial noise.

3) Bureau of Standards, Department of Public Works
Conducts noise studies for various City projects.

4) Department of Environmental Quality (Noise Specialist)
Aids Planning Department by conducting noise studies for Community Planning Environmental Impact Reports.

5) City Planning Department
Develops noise studies for Environmental Impact Reports and noise contour maps for freeways and state highways, and is developing the same for major arterial streets.

6) Police Department
Responsible for enforcement of some noise ordinances, (not requiring sophisticated monitoring).

Noise from All Sources--

In a 1971 survey conducted by the Los Angeles Department of Building and Safety it was concluded that the City had an average dBA level of

55.4. Twenty-four hour readings were taken at various locations throughout the Los Angeles area. The readings for each location were averaged and the site averages obtained were again combined. The result was the City-wide average dBA level.

Water

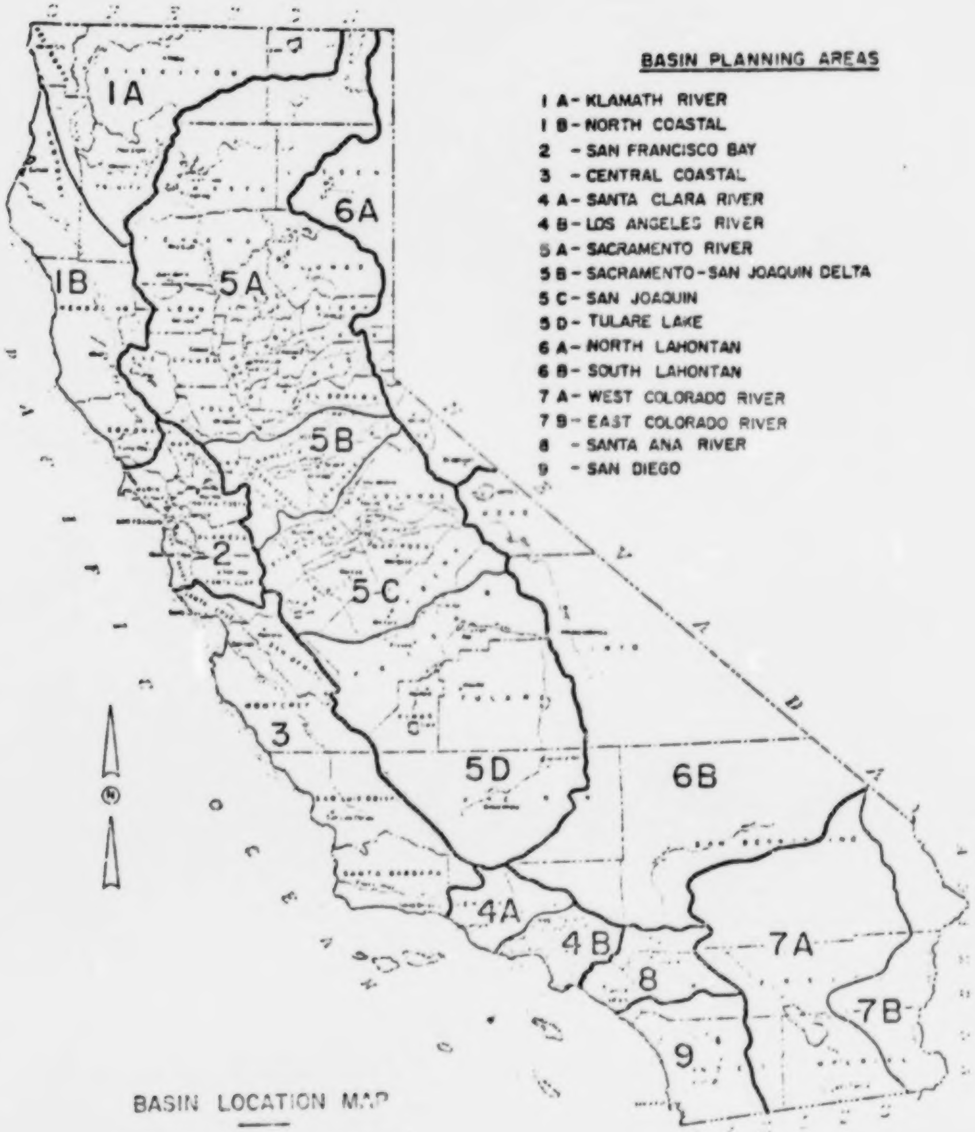
Introduction--

From the point of view of water quality, the coastal Los Angeles County basin may be regarded as a closed system which involves ground waters, surface waters, and ocean waters. In this system a very large but imprecisely defined volume of water is subject to change by various influencing mechanisms. These mechanisms include pumping water from the water table in the ground, precipitation in the form of rain and snow, evaporation of water from the surface, reclamation and reuse of used water, and importation of water. The quality and quantity of this water and the operation of the influencing mechanisms is the area of responsibility for the large number of water agencies in the area. These agencies include private water companies, agencies of county government, agencies of the state government, private individuals, and agencies of the cities in the area.

The many water agencies in the coastal Los Angeles area are responsible for monitoring and operating water programs, for conducting analysis for water planning, and for evaluating the awesome volume of data which has been collected over many years to describe the quantity and quality of water available within the region, or available to the region from outside sources. While the data is generally collected by the agency for its own internal purposes and to support the legislative responsibility given to it, there is also some general move toward developing a cooperative program of data collection. This cooperative data collection program is, of course, very desirable because the subject, the quality and quantity of water within the region, is the same in all cases.

To support this data collection effort, the approximately 1500 public and private water agencies have established data collection programs that involve literally thousands of people and thousands of stations from which samples are regularly taken. In most cases the samples that are taken are recorded on manually prepared forms. In some cases the forms are keypunched for storate and retrieval using computers. The use of computers to maintain this large volume of data is receiving more and more attention.

The water data sources in the Los Angeles area collect information for a region which includes a major portion of Los Angeles and Ventura Counties. This area is shown as State Water Resources Control Board Region Number 4 on the map in Figure 39. There are numerous data


BASIN PLANNING AREAS
1 A - KLAMATH RIVER
1 B - NORTH COASTAL
2 - SAN FRANCISCO BAY
3 - CENTRAL COASTAL
4 A - SANTA CLARA RIVER
4 B - LOS ANGELES RIVER
5 A - SACRAMENTO RIVER
5 B - SACRAMENTO-SAN JOAQUIN DELTA
5 C - SAN JOAQUIN
5 D - TULARE LAKE
6 A - NORTH LAHONTAN
6 B - SOUTH LAHONTAN
7 A - WEST COLORADO RIVER
7 B - EAST COLORADO RIVER
8 - SANTA ANA RIVER
9 - SAN DIEGO
1A
1B
6A
5A
5B
2
5C
3
5D
6B
4A
4B
8
7A
7B
9

BASIN LOCATION MAP

INTERIM WATER QUALITY
CONTROL PLAN CALIFORNIA REGIONAL
WATER QUALITY CONTROL BOARD
1971

Figure 39. State Water Resources Regional Board Areas

Reproduced from
best available copy.

sources for this region at the federal, state, county, city and special district levels of government, as well as in private industry. These sources and their general responsibilities are described below.

Los Angeles County Flood Control District (LACFCD)--
The LACFCD is responsible for the program of county-wide flood control, which includes an extensive network of flood control channels, the natural water courses of which the channels are a "civilized" extension, reservoirs that are part of the surface water system, and water quality and meteorological data collection related to this program of flood control.

Los Angeles Regional Water Quality Control Board (RWQCB)--
The RWQCB is the Southern California Area of the State Water Resources Board. This Board is responsible for the program of comprehensive water quality monitoring and research, and when indicated, instituting programs of water quality improvement. As part of this larger responsibility the Board produces state and regional water quality plans which are the basis for budgeting EPA and state funds for water quality-related capital projects such as sewers.

Private Industry--
There are some 1400 light to heavy industrial installations in the region that pump basin water for their processes or that have their own waste water treatment facilities. These water pumping and treatment facilities must be licensed by the RWQCB, and in some cases by other water agencies depending upon the type of industry and its location. The licensing entails a requirement for the regular submission of reports on water quality at regular scheduled intervals.

Southern California Coastal Water Research Project (SCCWRP)--
This organization was established as a research agency for a region that includes Ventura and Los Angeles Counties, the cities of Los Angeles and San Diego, and the sanitation districts of Orange and Los Angeles Counties. SCCWRP is a joint powers agency that has conducted research since 1969 into the effects that waste water discharge has had on the ocean off Southern California. The essence of this research is summarized in one of their publications, "The Ecology of the Southern California Blight: Implications for Water Quality".

The Sanitation Districts of Los Angeles County (LACSD)--
There are approximately two dozen sanitation districts involved in a joint program to process and discharge treated municipal wastes for Los Angeles County. The LACSD also manages sanitary land fill sites and operates waste water reclamation plants. The LACSD collect physical, chemical, and biological data for analysis.

Los Angeles Department of Water and Power (DWP)--
DWP is the water and power utility for the City of Los Angeles. Their programs include water pumping and importation, and power production and distribution. The department has an extensive data collection and analysis function that is based on its programs.

Central and West Basin Water Replenishment District (CWBWRD)--
This district was formed especially for replenishing the groundwater resources available within the southern portion of Los Angeles County. Specifically, this district's program is to adjudicate extractions to insure that they remain within limits set by the courts, to eliminate overdrafts by supplementing limited local water supplies with imported and reclaimed water, and to operate a program of injection wells to create a freshwater barrier along the coast.

State of California Department of Health (SDH)--
The SDH is responsible for insuring that the public water supply is within limits established for human consumption. For Southern California this translates as a program to monitor the public water supply for approximately 250 public and private agencies that operate pumping or water distribution facilities. The Los Angeles County Department of Health participates in this program of water quality monitoring.

Private and Public Water Companies--
There are a number of private water companies in the Los Angeles area that are engaged in water production and distribution programs. They are part of the same 250 public and private companies in the region.

City Departments of Public Works--
The public works departments of the cities in Los Angeles County are variously involved in water programs and therefore, to some extent, in collecting and analyzing water data.

California State Department of Water Resources (DWR)--
The DWR is a state-wide agency that is involved in many aspects of water. This involves programs such as the California Water Program, and participation with other agencies in joint programs including data collection. These program involvements include extensive collection of data about ground and surface water, meteorological conditions and reclamation.

Sea Grant Project (USCSG)--
The Sea Grant program is housed at USC and is responsible for research related to ocean waters and the ocean-groundwater interface. This research has resulted in a number of monographs concerning physical processes and chemical and biological characteristics of water.

U. S. Environmental Protection Agency (EPA)--

The federal impact on water quality and the programs of EPA are well known. In support of these and local programs, the EPA has developed a nation-wide system to store water quality data that has the acronym STORET. This is a teleprocessing system, based on computers located in Washington, D.C., which permits water agencies throughout the nation to input their data for storage through a terminal, and request analysis of the data that they or other agencies may have stored in the system.

Other Federal Agencies--

Other large federal agencies are engaged in programs to collect and distribute data related to water quality. These agencies include the U.S. Weather Bureau, U.S. Coast and Geodetic Survey, Department of the Interior and Department of Housing and Urban Development.

A summary of data items collected by the sources generally described above is shown in Figure 40.

Land Use

Introduction--

The land use data sources in the area collect information for the 4,079 square miles of Los Angeles County. There are significantly fewer sources, collecting less specific data, than those collecting water quality data. In spite of this there are some ninety agencies that, in greater or lesser degree, collect land use data. These include the cities in the County, two agencies of County government, State agencies, two Federal agencies and a number of private companies. As in the area of water quality the agencies have overlapping areas of responsibility which leads to duplication in data collection. In addition, there is far less compatibility of data between land use oriented agencies than there is for water agencies. Thus, while much data was reviewed, only that data which covers the largest number of agencies and which has the greatest historical continuity is proposed for use in development of environmental quality indicators.

Los Angeles County Regional Planning Department (LARPD)--

The County Department of Planning has responsibility for preparation of the general plan and community plans for unincorporated areas in the County. This responsibility is based on the Los Angeles County Charter and planning laws for the State of California. In fulfilling these responsibilities the Planning Department assembles land use and related data for the 4,079 square miles and approximately 1,800,000 parcels in the County.

Los Angeles City Planning Department (LACPD)--

The Los Angeles City Planning Department possesses the same legal authority and responsibility for government planning as the other 77

	Dept. of Water Resources	L.A. County Flood Control District	L.A. Regional Water Quality Control	Private Industry	So. Calif. Coastal Water Research Project	L.A. County Sanita-tion Districts	L.A. City Dept of Water and Power	Central/West Basin Water Replenishment	State Dept. of Health	County Dept. of Health	Public and Private Water Companies	Sea Grant Project	Environmental Protection Agency	U. S. Coast and Geodetic Survey	Department of Agriculture	Harbor Depts.
pH	X		Collects Data From Every Other Water Agency	X	Collects Data From Every Other Water Agency	X	X				X	X	X			X
Temperature	X			X		X	X				X	X	X			X
Water Level	X						X	X					X			
TDS	X			X			X				X	X	X			X
BOD	X			X			X		X	X	X	X	X			X
Turbidity	X			X		X	X				X	X	X			
NO_4	X					X	X		X	X		X	X			
PO_4	X					X	X		X	X		X	X			
CR	X								X	X	X		X			
Radioactivity	X			X		X	X		X	X	X		X			X
Electrical Conduction	X			X		X	X				X	X	X			
Calcium	X						X					X	X			
Magnesium	X						X					X	X			
Sodium	X						X					X	X			
Potassium	X						X					X	X			
CO_3	X						X					X	X			
HCO_3	X						X					X	X			
Chlorides	X						X					X	X			X
Florides	X						X					X	X			
NCH	X					X	X		X	X	X	X	X			X
Sulphates	X						X		X	X	X	X	X			X
Coliform Count				X		X			X	X	X	X	X			X
Oil and Grease				X		X			X	X	X	X	X			X

Figure 40. Water Data Items and Data Availability by Source

cities in the County and the County Planning Department, but is technically more advanced than the other governments in the area.

State Department of Water Resources (DWR)--
In 1929 the California Legislature enacted legislation providing for land use surveys throughout the State of California. For coastal Los Angeles this survey has been conducted in 1955, 1960 and 1974. Primary data used in these surveys in available from 1888 to the present. This survey is based on aerial photos and USGS maps, and is recorded in DWR publication #24 entitled, "Coastal Los Angeles County Land and Water Use Survey". The land use codes employed by DWR are shown in Appendix B.

Los Angeles County Assessors Office (LACAO)--
The County Assessor records data concerning land for use in preparing real estate tax billing reports. The Assessor is responsible for maintaining this data for each of the circa 1,800,000 parcels of land in the County. The data includes information about land use and zoning for each parcel. The land use classification scheme used in this file is unique to the Assessor's office.

Private Companies--
There are several corporations in the area that regularly make overflights to produce aerial black and white and color infrared (CIR) photographs. An example is the Metrex Corporation, which maintains a file of aerial black and white photos at 1" = 200' scale and zoning plot maps at 1" = 200' and 1" = 100'. These products are available at a nominal charge for individual prints or atlas books. A partial catalog of recent photographic and CIR mapping is provided in Figure 41.

Federal Agencies--
The Federal Government, through a number of its agencies, has for some time been engaged in programs of collecting land use or land use-related data. These programs have accelerated with the advent of new technical developments in aerial photography and mapping and computer-based information systems. These technically based programs are especially evident at NASA where ERTS imagery is often used, along with RB-57 intermediate altitude imagery, to study land use. Among the agencies with a longer history in this area, the Department of Agriculture is perhaps foremost in their program of classifying soils based in part on aerial photos. The Department of Interior has likewise been involved in land use data collection for areas within its legal domain, such as Indian lands and national parks. When a national land use act is finally passed, it is highly probably that administration will fall within Interior's jurisdiction, which will also probably increase land use data collection programs generally.

Aerial Photographs

Acquisition & Availibility (Black and White)

YEAR	CO.	AREA	DESIG.	SCALE	COSTS
1960	Teledyne	L.A. Basin	C 23870	1:14,400	1950-1965 Photos:
1961	Teledyne	San Fernando V.	24040	1: 6,000	1st 50: $5.76 ea.
"	"	"	24068	"	$1.80 ea. thereafter.
1962	Teledyne	Santa Monica	24385	1:14,400	1965-1974 Photos:
		to Norwalk			1st 10 50 100
1962	Teledyne	Los Angeles	24440	1:12,000	$13.344 $4. $2.4396 ea.
"	"	"	24455		After: $12.96 $1.44 $1.08
1961	Teledyne	Los Angeles			
		& Ventura Co.	C 24153	1:12,000	
1971-Apr.	Teledyne	L.A. City	-----	1:12,000	
1973-Feb.	Teledyne	L.A. City	-----	1:24,000	
1969-Oct.16	Fairchild	L.A. City	-----	1: 4,000	Roughly the same as Teledyne
1973-Oct.12	Fairchild	L.A.	-----	1: 4,000	
1970-Jan.	VTN[c]	L.A.	-----	1:48,000	Roughly $25. ea.
1972-Apr.	VTN	L.A.	-----	1:48,000	" " "
1974-June	VTN	Santa Monica Mtn.	-----	1: 6,000	Unknown

Orthophotos can be constructed by teledyne and VTN for about $200. per "neat" phot. Cost for photomosaic: $30. per original negative, $60. per copy negative, $7. per sq. ft. of mosaic.

(a) Tele'yne Geotronics, 725 East Third Street, Long Beach, California. 90802
Ask for Quincy (213) 435-8326, or (213) 775-1059.

(b) Fairchild Aeromaps, 14437 North 73rd Street, Scottsdale, Arizona. 85254
Telephone: (800) 528-7350.

(c) VTN, Associates, 2301 Campus Drive, Irvine, California. 92664
(714) 833-2450, ask for David Morales.

Figure 41. Partial Listing of Aerial Photographic Imagery for L. A. County

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Southern California Edison (SCE)--

Among the utilities SCE possesses both the greatest interest and employs the largest number of people in land use studies. However, SCE relies fairly heavily on the same major sources as other local agencies, such as the County Assessor and aerial photos. SCE is, therefore, not a good source of primary land use data.

South Coast Regional Commission--

This commission, established by a ballot proposition, possesses legal planning authority for the strip of land along the California coast and within five miles of the mean high tide line. Its responsibilities also include development permit authority for the strip of ground that lies within 1000 yards of the mean high tide line. Because of these responsibilities the Commission is involved in a program of land use data collection used in preparing coastal plans. Once again, however, this commission obtains its data from the same primary sources as other agencies.

Southern California Association of Governments (SCAG)--

This Council of Governments is responsible for preparing regional plans and for certifying grant applications for local governments in the region. In fulfilling these responsibilities SCAG collects and analyzes land use data from the familiar primary data agencies.

Solid Waste

Overview--

The California Senate has passed a law requiring the fifty-eight counties to provide Master Plans for 1980. Included in this is solid waste management. The City of Los Angeles, while constituting the major land area and population portion of the County, is not part of the County solid waste program. The Los Angeles County Sanitation District, a quasi-legal arm of the County, services unincorporated areas of the County and any cities that they have contracted with for service. The Los Angeles City Bureau of Sanitation services only the City.

One of the difficulties with this arrangement is the unnatural border of the City. The jagged lines of the border often cut through neighborhoods, not following geographical tendencies. The border statistical census tracts are not congruent, thus making comparisons between census data and city data on solid waste management impossible.

The policies of the Bureau of Sanitation and the County Sanitation District make the compilation of complete data difficult for the following reasons:

1. The Bureau of Sanitation only collects from single and small

multiple dwelling units (less than 4 units). Large multiple dwelling units, commercial buildings, and industry must contract with private companies for service.

2. Private companies are not required to make public the amount of their collections and disposals or costs.

3. The County Sanitation District does not have breakdown figures on the amount disposed in their various landfills by the private collectors of city refuse. Nor, are private collectors limited to collection from only city areas.

Energy

Two agencies at the County level and two at the City level are directly concerned with energy usage. In each case one agency focuses on energy use per se and the other on the polluting side-effects of energy use.

At the County level, a Los Angeles County Energy Coordinator functions in the Chief Administrative Office. The coordinator maintains a library on energy-related matters and does special investigations on energy use and fuel saving possibilities, particularly fuel saving by county government agencies. Also at the County level, the Air Pollution Control District monitors fuel usage within the County. The primary concern of this agency is the air pollutants being generated by fuel consumption.

At the City level, the Mayor has an Energy Coordinator whose office is concerned with fuel conservation measures and energy usage generally within the City. The Department of Environmental Quality is also concerned with energy use, particularly as it affects air and noise conditions within the City.

CONCLUSIONS

CAB has proven that government officials from the Mayor and Councilmen on down need data organized by geographical areas. To identify the best area breakdown for policy making purposes, the raw data must be by very small geographic area, namely, census tracts.

This is not to say that this is the only way the data should be organized. In particular, environmental data is also needed in breakdowns that reflect the natural divisions and entities of the particular system. Air data is needed by monitoring station and air basin. Noise data is needed by major noise sources. Water data is needed by natural divisions of the water basin, by well, and so forth. Solid waste data is needed by landfill site, solid waste material category, collection system, and disposal system. Energy use data is needed by fuel type, use category and so forth.

The point is that the CAB has proven that a wide variety of data sliced uniformly in a certain way is relevant to the problem of how to manage urban affairs. And this demonstration now demands that the entire process of environmental data collection be reviewed for the purpose of modifying it to efficiently serve a diversity of needs for environmental data.

Hopefully, this project can serve to spotlight this need. Unfortunately, the project did not include an assessment of the excess costs of serving CAB as well as traditional data needs with the present system compared to a redesigned one. The project did uncover evidence that the cost is substantial, however.

The inadequacy of the ambient air pollution and noise data for CAB purposes is one piece of evidence. The redundancy of water data means existing excess data collection costs, and the lack of data by census tract means further data processing costs to serve CAB purposes. The inconsistency and duplication of land use data points to cost excesses. The unavailability of solid waste and energy data by city, let alone census tract, raises questions as to the adequacy of the existing data collection system for existing agency purposes.

It is probable that a revised environmental data collection system designed to efficiently serve all basic managerial information needs could do so at a net reduction in cost. There is much duplication. The entire data collection system is based on obsolete design concepts that result in inflexible, single purpose filing and report generating systems. A modern system would focus on capturing items once and then tagging and storing them in such a way that they are readily available to a multiplicity of users for purposes not even recognized at the time of data capture. Flexibility and the value of data as a resource should be the keynote of the design.

A second important conclusion that has emerged from this investigation is that the CAB-type data base should be available on a County-wide basis. The City boundaries are arbitrary and and irrelevant with respect to all environmental variables (air, noise, water, land use, solid waste and energy). It probably costs as much to set up a CAB-type database on a city-wide basis as it does to set it up on a county-wide basis. One major cost is the fixed cost of system design and development. This is virtually the same for a county as for a city scope. A major operating cost is data collection and in most cases this can only logically be done on a county basis. Thus, from both an economic and managerial standpoint, expansion of CAB-type database from a city to a county scope makes good sense.

SECTION VI

DATABASE USAGE IN LOS ANGELES

INTRODUCTION

Data Availability

What is the difference between "data" and "information"? In the data processing profession data refers to symbols and information to their meaning. In top management circles, however, there is a distinct value connotation. Data is abundant and worthless; information is scarce and valuable.

The reason for the value connotation may be only partly attributable to incompetence in the EDP profession and those responsible for the function in organizations. Another factor may be that information is inherently unpredictable. Almost by definition "information" is new, something previously unknown that affects the learner's actions and attitudes.

For those who give substantial weight to the possibility that information is unpredictable, the most important functional goal of data processing is to make a wide variety of data easily and cheaply obtainable. This does not mean filling warehouses with endless printouts. It means organizing a capability to produce a wide range of data, but only on demand.

This design philosophy of making data easily available and sharable has been followed by CAB with respect to the nonenvironmental database it has assembled. The database is available on-line to all City agencies served by the City's Data Service Bureau. It is known to be the quickest and easiest way to get specific detailed facts.

The fact that environmental data will become available to all City agencies in the same way as other CAB data is an important indicator of the expanded usage of environmental data that will derive from this project. For a discussion of the types of usage this might involve the reader is referred to the beginning of Section 4.

Examples of City Reports Which Will Include Environmental Data

CAB--
The Community Analysis Bureau has regularly prepared a State of the City Report. This report is reviewed by City decision makers. From now on the environmental data collected will be available for inclusion in this study.

It also prepares Councilmanic District Reports which review a Councilman's specific problems. The environmental data will also be included in these studies.

DEQ--
The Department of Environmental Quality has the responsibility for preparing annual survey of environmental conditions as well as processing Impact Reports. The new data will prove invaluable to both of these projects.

Department of Planning--
The Los Angeles City Planning Department prepares plans for the thirty-five community areas in Los Angeles. One significant aspect to the planning process is an environmental awareness. This data will be incorporated into these plans as well as the Seismic Safety, Open Space, and Transportation Elements of the General Plan.

Special Studies--
The CAB as staff to the Office of the Mayor responds to many special study requests from the Mayor, Councilmen and other City departments. Many of these requests involve environmental factors. This data will now be available for inclusion into these studies which go directly to the decision makers in the City.

COMMUNITY ANALYSIS BUREAU USAGE

As a staff office to the Mayor, CAB receives many questions pertaining to the condition of the environment. These questions will be reviewed and a study design developed to incorporate the newly acquired environmental measures into the statistical studies regularly made by the Bureau. An evaluation will be made of the statistical interrelationship between the measures of environmental quality and socio-economic, demographic and structural variables that now exist in the City-wide database.

The results of these studies have and will continue to be made available to all City departments. In this way they will become more familiar with the information available and, as a consequence, will begin to make more use of this new information. This will insure a continued consideration of environmental concerns when decisions are made on City-wide planning or City policy.

Scope

One of the shortcomings of the Community Analysis Bureau's data evaluation procedure noted in Section 5 was due to the analysis being limited only to the City of Los Angeles. This left geographical gaps within the City as well as in the peripheral areas. For the purposes of this grant, this general scope covering only the City of Los Angeles was assumed to continue. However, it is felt that the analysis should be expanded county-wide.

This expansion should be made for a variety of reasons, the most important being that environmental conditions do not change at municipal boundaries. This is why most of the data is not easily available on a city basis. Air pollution, noise, water, land use and energy data are all collected by county areas and subareas. Thus, one use of the environmental database will be to forward the development of a county-wide CAB-type database.

In the remainder of this discussion of CAB usage of the environmental data, it will be assumed that the scope is county-wide. The steps to be taken in assembling a county-wide CAB-type database will be described. Then the method of analysis that CAB anticipates using in studying the database will be explained. It is hoped that this shift in geographic perspective will demonstrate the method by which the transition can be made to solve a broader problem with the same analytical techniques.

Nonenvironmental Data

Data aggregated for each of the Los Angeles County census tracts is presently available from three sources: the U.S. Bureau of the Census, the Los Angeles County Assessor and the Los Angeles County Health Department. Other social indicators are available from the State Board of Education and the Los Angeles County Probation Department. However, neither of these sources aggregate by census tracts and, consequently, additional effort would be required in the preparation of correspondence tables.

For brevity, it will be assumed that only census and assessor's data will be included in the County-wide database. The Community Analysis Bureau has been able to analyze, test and debug these computer files. These tapes alone will provide over 250 indicators of social, economic, demographic and structural conditions. If additional time and money become available, the data will be structured to enable the addition of any number of health, education or probation variables that can be calculated.

Census data will be obtained from the first, second and fourth count 1970 tapes. These will include variables on race, income, family size, education, employment, structural size, structural age, overcrowding, rent, housing value and plumbing facilities. The Assessor's data will include counts of parcels by use (residential, commercial or industrial), counts by zoning, assessed value, land value, improvement value, and incompatible use and zoning. A complete list of the raw count data variables to be included is presented in Appendix C.

Since the statistical analysis that will be done is on the basis of the Los Angeles County census tracts, and since all of the census tracts are not of similar population or size, a normalizing technique must be used to standardize the data. The simplest form of standardization is to work in terms of percentages and rates. For this reason a second list of data must be created which uses the raw data counts of the above figure to calculate the relevant variables. The standardized data would be comprised of desired rates and percentages developed from that data, including all of the significant social, economic and structural parameters. As an example of this process, "Count of all Persons" (VAR002), and "Count of Persons Aged 0-17" (VAR003), could be combined to calculate "Percent Persons Aged 0-17" (VAR003/VAR002)*100).

Environmental Data

The environmental data will cover all of the indicators possible with the limitation that they must be measured or estimated at a census tract level. These include those variables identified in Section 4 for air, water, land, noise, solid waste and energy.

The indicators now available on a census tract basis include the CAB Environmental Quality Index (based on Color Infrared Aerial Photos) and statistics on air, water, land and noise.

The air indicators include the two measures discussed, the Oxidant Episode Day and the ORAQI index. Also included would be the five major air contaminents; oxidants, carbon monoxide, sulfur oxides, nitrogen dioxide and particulate matter.

The water data available on a census tract basis is more limited. Data is available on the consumption of water, amount of precipitation, evaporation rates, the depth of the water table and the total dissolved solids (TDS) in the water. These data items are available by census tract.

The land data has already been significantly covered by both the census and assessor descriptions of the land use and structural characteristics. Additional data is available on the acreage distributions which would be included, the urban/suburban acreage ratios, and counts of acres devoted to open space, residential, commercial and industrial use. An indicator on density, population per acre, describes the intensity of residential land use.

Although there is relatively little data collected on a regular basis on noise, there are some sources measuring the intrusive noise levels. These measure the noise emanating from airports and freeways. These facilities create severe noise problems and consequently impact the surrounding areas. The area of impact has been measured and thus a measure of the percent of a census tract impacted can be determined.

The twenty-five variables listed in Figure 42 complete the census tract level environmental database in Los Angeles. These data items can be used in conjunction with the socio-economic data to calculate significant rates and percentages. An example of this would be the calculation of gallons of water consumed per capita (Gallons/Population count). This database would be appended onto the nonenvironmental indicators to create a computer file with one record per census tract.

One last file needs to be created, the geographical indicators. Each census tract belongs to one of several larger geographical areas, a planning area, statistical area or councilmanic district. By providing this information, the data can be summed to determine significant characteristics for any geographical area desired. The list of geographical indicators is in Figure 43.

Quality Assurance

There are many steps involved in determining what constitutes accurate data, identifying it by source, retrieving it from the original documentation, changing it to the form required for statistical analysis. Each of these steps requires careful computer processing, and the chances of error increase with each handling of the data.

For this reason the quality assurance phase has become an integral part of all Community Analysis Bureau processing. The two steps involved in this phase are 1) to spot-check randomly selected census tracts on the final tape against the original tape, and 2) to check county totals against the published results of the originating agency.

Both of these steps can identify sources of error and may provide an indication of the reason any error was made. These steps have the added advantage of familiarizing the analyst with the data before the actual

ENVIRONMENTAL QUALITY RATING (CIR PHOTO)

Air

Oxidant Episode Days
ORACHI
Oxidants
Carbon Monoxide
Sulfur Oxides
Nitrogen Dioxide
Particulate Matter
Temperature

Water

Gallons Consumed
Precipitation
Evaporation
Water Table Depth
TDS in Water Table
Relative Humidity

Land

Urban/Suburban Acres
Total Habitable Acres
Open Space Acres
Residential Acres
Commercial
Industrial
Population Per Acre
Topography

Noise

Intrusive Noise Levels
Impact from Airports
Impact from Freeways

Figure 42. 1970 Environmental Data

1970 Census Tract

Planning Statistical Area Number

CAB Statistical Area Number

Statistical Area Name

Planning Area Number (2 Digit)

Planning Area Number (3 Digit)

Planning Area Name

Geographic Area Number

Building and Safety Area Number

Geographic Area Name

Planning District Number

Planning District Name

Council District Number

Councilman's Name

Figure 43. Geographic Indicators

statistical interpretation must begin. The familiarity with the data aids in interpretation and explanation of the final results.

The quality assurance phase includes the development and writing of computer programs to test the data, the determination of printed sources of data for cross checking, and finally the comparison of the printed data with the processed data at both the census tract and county total levels. This will require an estimated minimum elapsed time of four weeks. Additional time will be required depending on the number and complexity of discrepancies discovered.

Variable Analysis

Once the data collection and quality assurance work has been completed, the statistical analysis portion of the work can begin by arranging the data in matrix form, with the social, economic, structural and environmental indicators as the horizontal elements and the geographical indicators, the 1,600 Los Angeles County census tracts, as the vertical elements. The variable analysis then reduces the data to the most significant variables. It shows which social, economic, structural and environmental variables are related. Then the geographical analysis provides information on which areas within the County, although they may be far apart in distance, are close in terms of their descriptive characteristics. The geographical analysis is confined to those variables found to be "significant" by the variable analysis.

The analysis of the variables will incorporate three statistical tools: correlation analysis, factor analysis, and cluster analysis. In all cases all of the available variables will be included and the sample size will be about 1,600, the number of County census tracts.

The correlation analysis will produce a simple correlation matrix. From this, variables with high degrees of association (positive or negative) can be ascertained. A listing will be made of those variables with a statistically significant correlation. Consideration has been given to running a series of two-way and three-way correlation analysis. These analyses would give insight on the relationships between pairs of variables. Tests are now being run on the effectiveness of the programs and the information which can be derived.

Factor analysis will provide a listing of the primary factors, or vectors, involved in the data being used. For example, in previous work an affluence vector has been identified which is indicated by the strong association of income, housing value, employment and education. The factor analysis provides a factor score and a coefficient for each of the varibles included, which is effectively a weighting mechanism. Tests are now being run to determine the usefulness of factor analysis in deriving a composite variable through the factor weights of the individual variables. If an "environmental factor" can be identified, it may be preferable to use it rather than using the individual variables with equal weights.

Cluster analysis can be used to determine the association of groups of variables. Again, the cluster results can be used to evaluate the weighting mechanisms involved in the analysis. The cluster analysis does have some advantages over factor analysis, in that the assumptions required about the data set are not as rigorous. In cluster analysis, a measure of association can be computed to identify those groups of variables that are highly related.

Other techniques have been used, including regression analysis and canonical analysis. The regression method could be used where predictions or estimates are necessary. Canonical analysis could be used when combination of the variable structures are of concern and there is an interest in the maximum amount of correlation between linear functions of two groups of variables.

Geographical Analysis

When the variable analysis is completed, a series of indicators is identified which constitute the primary focus of the study. These indicators then become the dimensions on which the geographical analysis is performed, and any conclusions about geographical similarity are only relevant with regard to this subset of variables.

The geographical analysis is a cluster analysis of the census tracts based on these key variables. More than one clustering of census tracts can be made with increases in the dimensions of interest. For example, clusters based on housing and environmental parameters may be considerably different than clusters based on industrial and environmental parameters.

A geographical clustering will produce mapping of those geographical subareas of the County which have similar characteristics. The number of the clusters and the degree of similarity attained will depend on the problem under evaluation.

Another technique which could be used in the geographical analysis is discriminant analysis. Given the characteristics of each geographical cluster, a discriminant function can be developed. This function allows the statistical allocation of each census tract to a cluster. The discrimination method is useful in identifying shifts in cluster compositions based on changes of the data for each census tract through time.

State of the County Report Implications

The statistical analysis of the variables gives information on the possible correlation of the data items. Are the environmental conditions related to land value, racial groups, health indices, education scores, etc.? Statistical information on these questions can provide concrete information on the programs needed to improve substandard conditions and the benefits that will result.

The statistical analysis of the geographical dimension will show areas of the County that are similar in terms of the variables used. It could be used, for example, to distinguish those areas of the County with high concentrations of air pollution, noise, auto ownership and industrial activity. The census tracts identified can be used as program target areas. If ten similar census tracts were identified, then five could be used for the recommended program and five used as control areas. On the other hand, if a set of variables is descriptive of an undesirable condition, then all census tracts identified could be targeted for programs, as well as those census tracts which are transitionally in this stage.

The ultimate use of the information gained from this process, as developed by the Community Analysis Bureau, is intended for programs to improve urban conditions. A database is developed which is descriptive of the urban area, statistical analysis is performed to provide insights on the relationships of the indicators and the geographical areas, social problem areas are defined and their relative intensities are measured, and finally, program packages are identified, implemented and measured as to their effectiveness.

This project, with the assistance of the Environmental Protection Agency, has been directed toward the development of the first stages of this process. The Community Analysis Bureau in the City of Los Angeles will work toward the completion of this project through the remainder of the 1974-1975 fiscal year. The results will be delivered to the Mayor and City Council of Los Angeles for evaluation and decision on the program packages.

SECTION VII

FUTURE

MORE RESEARCH

IREM

The exploration of environmental quality indices initiated by the IREM project in San Diego resulted in an Initial System of indices. A great many possibilities were investigated, including the idea of a single grand index of environmental quality. Based mainly on data availability considerations, but also to some extent on cost/benefit criteria, an Initial System of indices was proposed and implemented. The fact that this was viewed as only an initial stage in index development should not be overlooked.

This Project

The Los Angeles environmental index development project has achieved a breakthrough on a different front. Progress has been made in understanding the best way to make environmental information available to City officials. For one thing, elected officials need information by election districts and constituencies. A councilman is interested in environmental data for his councilmanic district.

Another important point is that a database organized by census tract can be extremely useful in evaluating the toal effects of particular program and policy options available to local governments. This means that environmental data should be merged with social, economic and other types of data on the basis of small geographic areas.

Next Project

It has also become clear on this project that the Initial System of indices developed on the IREM project are not sufficient for effective management of an urban environment. The situation is similar to the information needed to run a business. Only a small business can be effectively managed with only the formal financial accounting statements.

Effective management of medium and large sized businesses require budgets, detailed inventory turnover ratios, sales forecasts and much other operating data. An urban environment is too dynamic and complex to be controlled by a few indicators of overall status at a certain point in time.

The Initial System of indices is necessary but not sufficient. For example, it is useful to have quantitative measures of ambient air conditions, but this does not tell what can be done to improve the situation. For that guidance information on pollutant emissions and meteorological conditions is needed. The Pollutant Effects Control Index proposed in the discussion of energy in Section 4 would constitute some of this needed information. This information, however, would point to emissions from older cars and the percent of sulfur in the crude oil as major determinants of the air pollution in Los Angeles. So, for managerial purposes, what is really needed are indices of future emissions from older cars and future sulfur content of the crude oil and refined products delivered to this area. This involves forecasting models and the analysis of time series.

The situation is the same with respect to noise, water, land use, solid waste and energy use. In all these problem areas formal management information systems need to be developed. They need not be any more complex or abstract than those used to manage a medium or large business. Simple models should be tried first. Additional features can be added as the need becomes obvious. A large improvement in the quality of information appears possible for a relatively modest investment in environmental management information systems.

ENVIRONMENTAL MANAGEMENT INFORMATION SYSTEMS

As one begins to investigate the data needed to effectively manage urban environmental problems a remarkable pattern emerges. In all cases the trail from symptoms to causes lead back towards energy variables!

Figure 44 depicts two dimensions of the scope and structure of a theoretical base of a city environmental information system. In the horizontal dimension the five categories of environmental problems covered in the project are shown. For each of these separate environmental categories the same five types of information are relevant. These are shown in the vertical dimension: effects attributable to environmental conditions, indices, exogenous conditions, polluting sources and polluting source activity determinants. Each column in the figure refers to one of these five types of information.

The information referred to in the figure that was investigated and gathered in this project is underlined. Most of the underlining is in

	EFFECTS	INDICES	EXOGENOUS CONDITIONS	POLLUTING SOURCES	POLLUTING SOURCE ACTIVITY DETERMINANTS
AIR	Health Corrosion	Oraqi Episode days Oxidants	Wind Speeds (1) Humidity (1) Precipitation (1)	Cars/Trucks* Power Plants* Refineries* Industrial* General heating* All above: ↙ Fuel Volume ↘ Pollutant rates	Fuel Prices* (1) Fuel demand* (1) Car Pooling* Mass Transit System* Intersection Stops* Electricity demand* Electricity prices* (1) Machinery & Appliance Efficiency* Imported Power* (1) Emissions control (1) Insulation* Thermostat settings* Solar Energy usage*
NOISE	Hearing Defects Other Health Effects Psychological Effects	DB Level at Sampling Stations	Traffic Accident Rates Crime Rates	Freeways* % of Pop. Impacted Airports: Takeoffs* Railroads Intersection stop/starts per Hour* Construction sites*	Traffic Volume* Noise factors (1) Air Traffic Volume* Stop Light Control System* Construction activity* Building Acoutics Noise ordinances

Figure 44. City Environmental Database: Scope and Structure

	EFFECTS	INDICES	EXOGENOUS SOURCES	POLLUTING SOURCES	POLLUTING SOURCE ACTIVITY DETERMINANTS
LAND USE	Real Estate Values Education Crime	Pop. Density % Open Space Recreation Zoning Variances Granted	Lakes Forests Views	Poor Planning Lack of Plan Enforcement	Planning: Budget (1) Staff Quality (1) Enforcement: Budget (1) Funding of Recreational, transportation*, and utility* projects Political support which depend on fuel prices*, housing needs, etc.
WATER	Health	% Drinkable % Dissolved Oxygen	Rainfall (1)	Salt Water intrusion Sewage Fertilizers	Water Prices (1) Imported Water* Water Reclamation* Agricultural Practices
SOLID WASTE	Polluting Effects	Tons Handled Value of Recovered Materials	Land Fill Capacities (1)	Landfill Areas Poor collection Service	Solid Waste Handling Budget (1) Economics of Reclamation* (1) Fuel Prices* (1)
ENERGY	Economic Effect of Shortage* Social Effects of Shortage*	Unlimited Source Usage* Efficiency* Side-effect* Control	Foreign Relations (1)* Weather	Lack of R & D on new sources (1)* Lack of efficient equipment and practices old vehicles* High sulfur oil*	Oil and natural gas prices* R & D funding for energy* Building practices and codes Desulfurization at refineries* Power Plant stack emission controls* Old vehicle emission controls*

Figure 44. (continued)

the column marked "Indices." There is some underlining, however, in the columns concerning Polluting Sources.

The data referred to in the figure that is directly concerned with energy use is marked by an asterisk. All the asterisks are in two columns shown on the left hand side except for that in the last row.

Note how energy variables dominate the air pollution source information. Responsibility for monitoring Los Angeles air quality and controlling stationary source emmissions lies with the Air Pollution Control Districts (APCD) of the South Coast Air Basin. Our investigations indicate that this agency has the best data on fuel consumption in Los Angeles County. This confirms the importance of energy information in taking actions that reduce air pollution.

The determinants of the amount of noise appear to be basically of three types. One is energy usage. The others are sound insulation usage and legal restrictions. Energy usage is the basic source of noise.

The relationship of land use to energy is not as easily defined, however, it could turn out to be just as dominant as in the case of air pollution.

A few examples will indicate the importance of energy considerations in land use patterns: Raise the price of gasoline and real estate values on the periphery of Los Angeles will decrease. Political support for mass transit will increase. Raise the price of natural gas and apartments will gain an economic advantage over single dwelling units.

Energy use is a major expense in the importation of water. This means that the price of water is related to the price of energy. Price is a most important determinant of the volume of water used which in turn affects water quality.

Solid waste is a potential source of energy. It also involves the consumption of energy in its collection and disposal or processing. The economics of producing metals, pulp fertilizers, and other products from solid waste versus virgin materials is very much affected by the cost of energy and transportation.

Implications

This relationship between energy matters and environmental problems has important implications. Two of them will be mentioned. One concerns government organization. The other concerns database organization.

The fact that the way energy use is managed determines, or at least strongly influences, environmental quality means that government at each level should be organized to closely coordinate energy and environmental policies and actions. It implies that if both areas are not handled by one agency the agency responsible for energy use will preempt other agencies in the field of environmental management. This will make it difficult for the other agencies to cooperate as equals with the agency responsible for energy.

There is no public evidence that this close relationship between energy and environment is consciously recognized at any level of government today. This is unfortunate because the development of a sound organizational framework is a prerequisite to building a cost/effective management information system. To attempt building an integrated database on an inappropriate organizational structure is foolish. Managers should lead the development of their management information systems.

The other implication, which is academic at this time, is that separate databases for air, noise, water and so forth would be inappropriate. Fuel prices, for example, affect many environmental problems, from air-pollution to solid waste. The database should be structured for efficient storage and retrieval of fuel price information no matter which environmental category the user is managing or investigating. This can be done using a generalized database management system when the time is right.

It is also important not to forget the third dimension needed in an environmental database. This is the geographical dimension. The information in a city database should be retrievable by councilmanic district so that representatives or particular districts can get specific facts for their district. Possible exceptions to this general demand for an intra-city breakdown are noted by a (1) in Figure 44.

Another important dimension that should be mentioned is time. Many types of data become more meaningful if a historical perspective is available. Historical perspectives are available on many of the underlined items in Figure 44.

TRANSFER OF RESULTS TO OTHER CITIES

This project involved transferring to Los Angeles the index concept developed for San Diego. This presented no particular difficulty. Air pollution problems are of the same type in the two cities. So are the noise, water, land use, solid waste and energy problems.

Approximately the same data types were found to be available in the two cities. This is because most environmental concerns involve County and

State agencies. The same data is probably available for the San Francisco Bay area.

The ease of transfer between Los Angeles and San Diego does not establish transferability in general. There are sound reasons for the position that the Los Angeles-San Diego transfer is unusually easy. Air pollution problems are quite different in New York, for example. Water quality problems are different in New York and of another nature in New Orleans. The economics of solid waste recycling would differ somewhat from city to city. Also, many cities use coal whereas Los Angeles does not.

There is also the fact that environmental data is collected by state and local agencies. While EPA may be promoting a strong central tendency in the types of data collected, there is no reason to assume the data is uniform from city to city. On the contrary, it is no doubt quite varied and for good reason.

Method of Approach

A major point in devising the best means by which other cities can benefit from the results of this work is to remember that information systems should be designed to meet the needs of a particular organization. From the preceding discussion it should be clear that appropriate organizational arrangements for dealing with environmental problems do not exist in government as a general rule.

This means that any support given to developing environmental indices should be calculated to influence government organization towards an integration of the responsibilities for energy and environmental affairs. The support given in Los Angeles is an ideal example. The CAB is in a neutral position as between energy and environmental management responsibilities. It has established a database that relied on the data collection efforts of many agencies. It was therefore natural that CAB extend its database into the areas of environmental and energy statistics.

The work of CAB in developing an energy-environmental database should be further supported. The expansion of matrix analysis and the development of regional environmental databases for use in urban decision making should be encouraged. As developed in this study, the expansion of the data base and analytical evaluation to cover the entire county would fill in the many gaps in the current analysis and provide a doubling of the sample size, which would increase the statistical significance of the results. The development of the data base in Los Angeles would be inexpensive, because of the infra-structure that already exists: the database, the analytical expertise, and the information channels between the analysis and the urban decision makers.

There are many problems yet to be resolved. One method of improving the data allocation to geographical units was recommended in the discussion of Air in Section 4. This involved SYMAP centroids and computerized interpolation. To do this, the base map has to be geocoded and an algorithm developed by which to distribute the data. Another air measure, Alert Days, could be developed using this method.

In Los Angeles, the water and land environmental areas both need assistance with the determination of needed data and the centralization of collection and dissemination. The responsibility in these fields is particularly disjointed, spread through several agencies, each with differing data requirements and uses to which the data is put. A centralization of purpose would provide more data.

At the same time there may be other cities with something similar to CAB in Los Angeles. Support of any interest such an agency has in extending its database into the environmental area could be profitable. In addition to forwarding an understanding of the relationship between energy and all urban environmental concerns it would develop an understanding of the variation in indices that are appropriate in different environments. This is needed to determine the degree of standardization in indices that is possible and desirable.

SECTION VIII

APPENDICES

APPENDIX A

INTERPOLATION OF ORAQI VALUES

A procedure for interpolating the ORAQI annual, or seasonal average values from the Los Angeles APCD data, to the census tract level has been developed, for implementation at a future date. This procedure is based on an extension of the plotting technique programmed by USCD, and is described in this appendix.

Procedure Proposed for Computerized Interpolation of Air Quality Values to the Census Tract Level

Air Quality data for Los Angeles and the surrounding area has been regularly monitored at approximately 16 points. To interpolate this information to the census tract level, air quality index surfaces will be generated over the entire region. These interpolated surfaces will match the monitored values at each monitoring site and will be used to estimate the values at the centroid location of each census tract, by picking the value given by the interpolated surface at that centroid location.

Air Quality Index Surfaces - The air pollution data used in this analysis will consist of total oxidant, carbon monoxide, nitrogen dioxide, sulfur dioxide and particulate matter measurements in the form of hourly averages for each test year (1970 through 1973). This data will be used to form three different air quality indices. The first is the Oak Ridge Air Quality Index, which combines all five pollutants:

$$\mathrm{ORAQI} = \left(5.7 \sum_{i=1}^{5} (C_i/S_i\right)^{1.37}$$

where C_i = yearly average concentration of pollutant i

S_i = EPA standard for pollutant i

The standards, listed on page 162, are extrapolated from the United States Environmental Protection Agency standards to a common 24 hour averaging time basis using the method proposed by Larsen. The second index consists of the number of days per year the oxidant level exceeded .08 ppm. The third index is the number of days per year .10 ppm of the oxidant was exceeded, for one hour or more.

These three yearly air quality indices will be compiled for each of about 16 monitoring stations in the Los Angeles air basin. The oxidant values monitored by the Los Angeles Air Pollution Control District will be multiplied by a factor of 1.4 in order to correct the inaccuracy recently discovered in the measurements being made by the Los Angeles APCD.

The index values will be interpolated two-dimensionally to form air quality surfaces over the entire county. (Figure 45) The interpolation algorithm is essentially that used by SYMAP. The surfaces will consist of 50 by 60 grids of index values. These surfaces will be further interpolated bilinearly in order to obtain the three index values at the centroid of each census tract in Los Angeles City.

Input - Census tract centroid locations for the City of Los Angeles are to be digitized (converted into machine readable form) for use by UCSD computer programs. LAAPCD and California Air Resources Board air pollution data tapes for the years 1970, 1971, 1972 and 1973 are to be used year by year as the sources of air quality monitoring data.

Output (for each year 1970, 71, 72, 73) -

1) ORAQI Air Quality Index surface plotted over L.A. map as in Figure 4.
2) For each census tract centroid (listed in numberical order of tracts).

oxidant das/yr over .08 ppm oxidant das/yr over .10 ppm	in both computer listing and card or tape record form

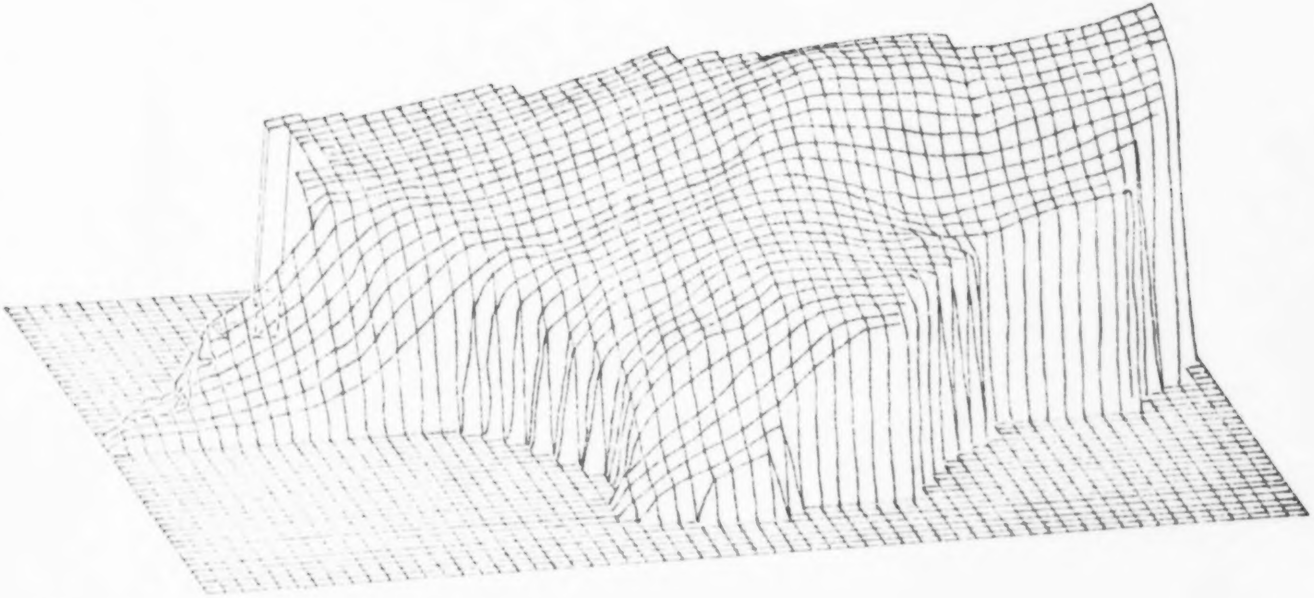

Figure 45. Air Quality Index, Los Angeles County, 1970

annual average Oak Ridge Index value

EPA and extrapolated standards - April 30, 1971

Pollutant	levels not to be exceeded more than once per year (ppm)			Extrapolated Standards (24 hr)[a]
	24 hr	8 hr	1 hr	
Oxidant (OX)			0.08	0.03
Particulate matter (PM)	260			150
Sulfur oxides (SO_x)	0.14			0.1
Nitrogen dioxide (NO_2)				0.2
Carbon Monoxide (CO)		9.0	35.0	7.0

[a] ppm except ug/m^3 for particulate matter

APPENDIX B

STANDARD LAND USE LEGEND USED BY CALIFORNIA DEPARTMENT OF WATER RESOURCES

State of California, The Resources Agency, Department of Water Resources

Standard Land Use Legend (Revised May 7, 1970)--
The minimum breakdown of land use is according to the "Class" symbol. More detail is obtained by adding the subclass number to the class symbol, or by use of special additional symbols. Any or all of the following information can be delineated.

1. Types of agricultural, urban, or recreational development, and kinds of native vegetation.

2. Kinds of crop for a given period.

3. Intercrop practices.

4. Source of water supply.

Agricultural classes (precede with "n" or "i")--
G--Grain and hay crops.

1. Barley
2. Wheat
3. Oats
4. Miscellaneous and mixed hay and grain

R--Rice

F--Field crops

1. Cotton
2. Safflower
3. Flax
4. Hops
5. Sugar beets
6. Corn (field or sweet)
7. Grain sorghums
8. Sudan
9. Castor beans
10. Beans (dry)
11. Miscellaneous field

P--Pasture

1. Alfalfa and alfalfa mixtures
2. Clover
3. Mixed pasture
4. Native pasture

T--Truck and berry crops

1. Artichokes

10. Peas

2. Asparagus
3. Beans (green)
4. Cole crops
5. Carrots
6. Celery
7. Lettuce (all types)
8. Melons, squash, and cucumbers (all types)
9. Onions and garlic
11. Potatoes
12. Sweet Potatoes
13. Spinach
14. Tomatoes
15. Flowers and nursery
16. Miscellaneous truck
17. Bushberries
18. Strawberries
19. Peppers (chili, bell, etc.)

D--Deciduous fruits and nuts

1. Apples
2. Apricots
3. Cherries
4. Peaches and Nectarines
5. Pears
6. Plums
7. Prunes
8. Figs
9. Miscellaneous deciduous
10. Almonds
11. Walnuts

C--Subtropical Fruits

1. Grapefruit
2. Lemons
3. Oranges
4. Dates
5. Avocados
6. Olives
7. Miscellaneous subtropical fruits

V--Vineyards (subclasses not mapped unless specified)

1. Table grapes
2. Wine grapes
3. Raisin grapes

S--Semiagricultural and incidental to agriculture (precede subclasses 1, 2 and 3 with "n", 4 with "i", and 5 with "n" or "i" as the case may be)

1. Farmsteads
2. Feed lots (livestock and poultry)
3. Dairies
4. Lawn areas
5. Cemetaries

I--Idle

1. Land cropped within the past three years but not tilled at the time of survey. Exception: If it can be determined that the land was cropped during one of the three previous "growing

seasons"[1], map the condition by indicating the crop and season.

2. New lands being prepared for crop production.

Unclassified--
E--Entry denied

Native Classes--(Do not precede with "n" or "i". Subclasses not mapped unless specified.)
NV--Native vegetation

1. Grass land
2. Light brush
3. Medium brush
4. Heavy brush
5. Brush and timber
6. Forest

NR--Riparian vegetation

1. Swamps and marshes
2. Meadowland
3. Brush
4. Trees

NW--Water surface

1. Lakes, reservoirs and rivers

NB--Barren and wasteland

1. Dry stream channels
2. Mine tailing
3. Barren land
4. Salt flats
5. Sand dunes

NC--Native classes unsegregated

Urban classes--
U--Urban

1. Residential, commercial and industrial (May be used alone when further breakdown is not required)

UR--Residential

1. One and two family units, including trailer courts (May be used alone when further breakdown is not required)

Type of Development (houses per acre)

UR 1_	0.5 to 2
UR 2_	3 to 6
UR 3_	7 or more

Water Use

UR _1	Irrigated yard
UR _2	Nonirrigated yard

Example: UR 21 indicates that the residential delineation has a density of 3 to 6 houses per acre, and that the yards are irrigated.

UC--Commercial (Indicate the number of stories following the appropriate subclass) (May be used alone when further breakdown is not required)

1. Miscellaneous establishments (offices and retailers)
2. Hotels
3. Motels
4. Apartments, barracks (3-family units and larger)
5. Institutions (hospitals, prisons, reformatories, asylums, etc., having a reasonably stable 24-hour resident population)
6. Schools (yards to be mapped separately if large enough)
7. Municipal auditoriums, theaters, churches, buildings and stands associated with race tracks, football stadiums, baseball parks, rodeo arenas, etc.
8. Miscellaneous high water use (specify use: to be used to indicate a high water use condition not covered by the above categories)

Example: UC 23 (3-story hotel)

UI--Industrial (Should not be used without subclass unless specified)

1. Manufacturing, assembling and general processing
2. Extractive industries (oil fields, rock quarries, gravel pits, public dumps, rock and gravel processing plants, etc.)

3. Storage and distribution (warehouses, substations, railroad marshalling yards, tank farms, etc.)

4. Saw mills

5. Oil refineries

6. Paper mills

7. Meat packing plants

8. Steel and aluminum mills

9. Fruit and vegetable canneries and general food processing

10. Miscellaneous high water use (specify use: to be used to indicate a high water use condition not covered by the above categories)

UV--Vacant (Should not be used without subclass unless specified)

1. Miscellaneous unpaved areas (vacant lots, graveled surfaces, playing fields, nonirrigated freeway strips, raw lands within metropolitan areas, etc.)

2. Miscellaneous paved areas (parking lots, runways, freeways, oiled surfaces, flood control channels, tennis court areas, auto sales lots, etc.

Recreational classes--

RR--Residential

Permanent and summer home tracts within a primarily recreational area. The estimated number of houses per acre is indicated by a number in the symbol. Example: RR-3 (3 homes per acre)

RC--Commercial

Commercial areas within a primarily recreational area. (Includes motels, resorts, hotels, stores, etc.)

RT--Camp and trailer sites

Camp and trailer sites within a primarily recreation area.

Additional symbols--

(i)--Irrigation

Denotes an irrigated crop and precedes class symbol. Example: iG1 - irrigated barley. Note: Refer to Fallow, Idle and abandoned for special uses of "i".

(n)--Dry Farm
Indicates a dry farmed crop and precedes class symbol. Example: nG1 - dry farmed barley.

(S)--Seed Crop
Indicates any crop grown for seed and is used following crop symbol. Example: iP1-S - irrigated alfalfa seed crop.

(Y)--Young non-bearing orchards and vineyards
Follows crop symbol. Example: iC3-Y - young non-bearing irrigated oranges.

(A)--Abandoned orchards and vineyards
Trees or vines must be in such a condition that renewal of cultural practices would restore economic production. Indicated by (A) following crop symbol. Example: iD1-A - indicates an apple orchard previously irrigated but now abandoned.

(F)--Fallow lands (Must be tilled at time of survey)

1. If no crop residue is apparent or identifiable then the "F" symbol will follow the agricultural class symbol for the crop most representative of those grown in the area. Example: iTF - Fallow truck crop land (with facilities for irrigation)

2. If the crop residue is apparent and identifiable but is not from the current crop season covered by the survey then the field is considered fallow and mapped as the class of the crop residue. Example: Surveyor found an old sugar beet residue not from current season. Land would be mapped iFF.

3. However, if the crop residue is identifiable as that of a crop which was grown during the survey period, then map the field as though crop existed. Example: iT6 - Carrot residue from current growing season.

(Z)--Reclamation
Land being leached for the removal of harmful salts. This symbol will be used following either the "Idle" symbol or symbols of crops grown as a step in the reclamation process. Examples: iI2-Z, iR-Z.

(M)--Military areas
Indicates lands owned or controlled by the military and is used following the land use symbol. Example: iF1-M - irrigated cotton within a military area.

(B)--Burned over areas (not mapped unless specified)
Indicated by "B". The type and density of natural cover destroyed by fire is obtained by examination of aerial photo. Example: NV2-B.

(P)--Parks
Indicates all types of parks, both public and private and is used following the land use symbol. Example: iS4-P - irrigated land area within a park.

(X)--Partially irrigated crops
Crops irrigated for only part of their normal irrigation season. Example: iP3-X - partially irrigated mixed pasture.

(a,b,c,d)--Growing season
Indicated by appropriate symbol following crop symbol: "a" - Spring; "b" - Summer; "c" - Fall; "d" - Winter. Example: iT12-d - Winter potatoes; iT12-a - Spring potatoes.

(fraction)-- Intercropping

Indicated by a fractional symbol. The crop symbol appearing first in order in the preceding legend will be mapped in the numerator Exception: When orchard or vineyard is intercropped with some other crop class, the orchard or vineyard symbol will appear in the numerator.

Examples: $i\frac{D5}{G1}$ Peaches intercropped with barley $i\frac{D5}{D13}$ Walnuts intercropped with peaches

(percentages)--Mixed land use
Indicated by percentages following land use symbols. No more than 3 symbols are to be used in describing the area. Example: iD5 - 40. NV - 20. UC32 -40.

For additional information refer to "Additional Symbols" on page 167 of the discussion of the land use legend.

Source of Irrigation Water	Pump	Gravity
Natural Stream		
Drain		
Well		
Other sources including lake, pond, reservoir, and oxbow		

APPENDIX C

COMMUNITY ANALYSIS BUREAU OF THE CITY OF LOS ANGELES

This appendix lists the data items contained in two files of the CAB Database for 1973. One file is called the SOCFILE. It contains indices calculated from another file, the SUMFILE, which is not covered in this appendix.

The other file for which data items are listed herein is the GEOCODE file.

The basic record on all CAB Database files contains data items relating to a particular census tract.

Community Analysis Bureau of Los Angeles, 1973 State of City DATABASE--

SOCFILE--

1. % Persons Aged 0-17 years
2. % Persons Aged 18-64 years
3. % Persons Aged 65+
4. % White Population
5. % Black Population
6. % Other Population
7. % Spanish Population
8. % Japanese Population
9. % Chinese Population
10. % American Indian Population
11. Median Family Income
12. Median Income of Unrelated Individual
13. % Families in Poverty
14. % Unrelated Individual in Poverty
15. % 65+ in Poverty
16. % Household with Rent/Income >25%
17. % Unrelated Individuals
18. % Inmates of Institutions
19. % Persons in Group Quarters
20. % Families which are Husband-Wife Families
21. % Families with Female Heads
22. % Other Families with Male Head
23. % Work Trips in Private Auto
24. % Work Trips on Public Transit
25. % High School Dropouts 16-21 Who are Male
26. % High School Dropouts 16-21 Who are Female
27. % of Persons 16-21 who have Dropped Out of High School
28. % 25+ Who Have Not Completed High School Who are Males
29. % 25+ Who Have Not Completed High School Who are Females

30. % 25+ Who Have Not Completed High School
31. % of Those Completed College Who are Males, 25+
32. % of Those Completed College Who are Females, 25+
33. % 25+ Who Have Completed 4 or More Years of College
34. Labor Force Participation Rates
35. % of Labor Force Which is Female
36. % Females 16+ Who are in Labor Force
37. % Males 16+ Who are in Labor Force
38. % Unemployed
39. % Unemployed Who are Females
40. % Unemployed Who are Males
41. % Females 16+ (Husband Present) Who Are in Labor Force
42. % Employed Males Who are White Collar Employment
43. % Employed Females Who are White Collar Workers
44. % White Collar Employed
45. % Persons in Families in Poverty
46. % Persons in Poverty
47. % Families Receiving Welfare
48. % Unrelated Individuals Receiving Welfare
49. Street Miles/Square Mile
50. % Units in one-unit Detached
51. % Units in one-unit Attached
52. % Units in two-unit Structures
53. % Units in 3-4 Unit Structures
54. % Units in 5-9 Unit Structures
55. % Units in 10-19 Unit Structures
56. % Units in 20-49 Unit Structures
57. % Units in 50+ Unit Structures
58. % Mobile Homes
59. % Vacant
60. % Renter Occupied of Total
61. % Owner Occupied of one-unit Detached
62. % Units with No Autos
63. % Units with 2+ Autos
64. % Owner Occupied Units with 1.01-1.50 Persons Per Room
65. % Owner Occupied Units with 1.51+ Persons per Room
66. % Renter Occupied Unit with 1.01-1.50 Persons Per Room
67. % Renter Occupied units with 1.51+ Persons Per Room
68. % Owner Occupied Units with Value Less Than $20,000
69. % Husband-Wife Family Occ. Units where Head Moved in 1965-70
70. % Husband-Wife Family Occ. Units where Head Moved in 1960-64
71. % Husband-Wife Family Occ. Units where Head Moved in 1950-59
72. % Husband-Wife Family Occ. Units where Head Moved in 1949 or Earlier
73. Median Value of Owner Occupied Housing
74. Median Rent of Renter Occ. Units
75. Median Imputed Rent
76. Median Persons Per Unit in one-unit Structure

77. Median Persons Per Unit in Multiple Unit Structures
78. Median Persons Per Unit in Occupied Units
79. % of Rented one-unit Structures where Gross Rent is Less Than $150
80. % of 2+ Unit Rented Structures with Gross Rent Less Than $80
81. % of Owner Occupied one-unit Structures Lacking 1 or More Plumbing Facilities
82. % of Owner Occupied 2+ Unit Structures Lacking 1 or More Plumbing Facilities
83. % of Renter Occupied one-unit structures Lacking 1 or More Plumbing Facilities
84. % of Renter Occupied 2+ Unit Structures Lacking 1 or More Plumbing Facilities
85. % Owner Occupied one-unit Structures built 1960-1970
86. % Owner Occupied one-unit Structures built 1939 or Earlier
87. % Owner Occupied 2+ Unit Structures built in 1960-1970
88. % Owner Occupied 2+ Unit Structures built 1939 or Earlier
89. % Renter Occupied one-unit Structures built 1960-1970
90. % Renter Occupied one-unit Structures built 1939 or Earlier
91 % Renter Occupied 2+ Unit Structures built 1960-1970
92. % Renter Occupied 2+ Unit Structures built 1939 or Earlier
93. Blank
94. Environmental Quality Rating
95. Subsidized Housing Units/Site (Section 221 (d3) and 236)
96. % Housing Units Which Are 221 and 236 Units
97. Section 23 Units/Site
98. % Housing Units Which are Section 23
99. % Subsidized Housing Units
100. Rate of High School Dropout 25+ to Dropouts Aged 16-21
101. Median Income, Families & Unrelated Individuals, Weighted Average
102. % Units Lacking 1 or More Plumbing Facilities
103. % Renter Occupied Units Lacking 1 or more Facilities
104. % Owner Occupied Structures Lacking 1 or more facilities
105. % Units with 1.01+ Persons Per Room
106. % Units with 1.01-1.50 Persons Per Room
107. % Units with 1.51+ Persons Per Room
108. Population/Square Mile
109. % Occupied Units Built 1960-1970
110. % Owner Occupied Units Built 1960-1970
111. % Renter Occupied Units Built 1960-1970
112. % Occupied Units Built 1939 or Earlier
113. % Renter Occupied Units Built 1939 or Earlier
114. % of the Population 16+ Who are Males
115. Median Imputed Rent/Median Weighted Income
116. Median Imputed Rent in Owner Occupied Units/Median Family Income
117. Park Acres within Access
118. Number of Parks

119. Number of Parks/Square Mile
120. Park Acres/Square Mile
121. Murders per 100 Population
122. Blank
123. Assaults per 100 Population
124. Robberies per 100 Population
125. Blank
126. Burglaries per 100 Improved Parcels
127. Dollar Loss From Burglaries Per $10,000 Improvement Value
128. Dollar Loss From Burglaries Per 100 Improved Parcels
129. Residential Burglaries Per 100 Occupied Dwelling Units
130. Dollar Loss from Residential Burglaries Per Occupied Dwelling Units
131. Dollar Loss Per Residential Burglary/Median Family Income
132. Suicides per 1000 Population
133. Attempted Suicides Per 1000 Population
134. Suicides & Attempted Suicides Per 1000 Population
135. Total Arrests/100 Population
136. Juvenile Arrests/100 Population Aged 0-17
137. Dependency Arrests/100 Population Aged 0-17
138. Narcotic Arrests/100 Population Aged 14-44
139. Traffic Arrests/100 Population Aged 16+
140. Drunk Arrests/100 Population Aged 18+
141. Juvenile Delinquent Arrests/100 Population Aged 0-17
142. Drunk Driving Arrests per 100 Population Aged 16+
143. Auto Thefts Per 100 Occupied Dwelling Units
144. Auto Thefts Per $10,000 Improvement Valuation
145. Structural Fires per 100 Improved Parcels
146. Non-Structural Fires per 100 Population
147. Non-Structural Fires per Square Mile
148. Smoking Related Structural Fires per 100 Improved Parcels
149. % Structural Fires which are in Residential Structures
150. Malicious False Alarms per 100 Population
151. Arsons & Suspected Arsons per 100 Population
152. Electrical Failure Structural Fires per 100 Improved Parcels
153. Count of Residential Structural Fires per 100 Occupied Units
154. Infant Mortality per 100 Live Births
155. Neonatal Mortality per 100 Live Births
156. Death of Persons Aged 25-44 per 100 Persons Aged 25-44
157. Blank
158. Blank
159. Blank
160. Blank
161. Births with Birth Weight Less Than 5.5 lbs., per 100 Live Births
162. Births with Birth Weight Less Than 5 lbs., per 100 Live Births
163. Average Age of Mothers at First Delivery
164. % Births to Mothers with Greater Than 4 Living Children
165. Average Month of Pregnancy when Prenatal Care Began
166. % of Births where Mother Had no Prenatal Care

167. School Year Transiency Rate In
168. School Year Transiency Rate Out
169. Median Sixth Grade Reading Score
170. Median First Grade Reading Scores, 1969
171. Median Third Grade Reading Score, 1972
172. Ratio of Median Third Grade Reading Score, 1972 to Median First Grade Reading Score, 1970
173. % Residentially Used Parcels (of Improved Parcels)
174. % Parcels in Commercial Use
175. % Parcels in Industrial Use
176. % Parcels in Institutional Use
177. % Vacant Parcel
178. % Residentially Used Parcels with Swimming Pools
179. Value of Private Recreation Uses/100 Population
180. # of Private Recreational Parcels/100 Population
181. Estimated Population Density Per Residential Area
182. Average Land Value per Parcel
183. Average Improvement Value of Parcels in Use 01
184. Improvement Value of Use 01/Land Value of Use 01
185. Blank
186. % Parcels Zoned High Density Res., Comm. & Manufacturing
187. % Parcels Zoned Comm. and Manufacturing
188. Chi Squared of Racial Balance--This will be on tape to be added directly to the SUM File.
189. Population/Park Acre Within Access
190. Population 0-17, 65+/Park Acre within Access
191. % Single Family Units which are Overzoned
192. % Residential Parcels where Zoning is not Residential
193. Blank
194. % Largest Ethnic Group
195. % Parcels Zoned for Single Family Units
196. % Parcels Zoned for Low Density Residential
197. % Parcels Zoned for High Density Multiple
198. % Parcels Zoned for Commercial Use
199. % Parcels Zoned for Manufacturing
200. % Parcels Where Zoning is Residential But Use is Commercial, Industrial
201. Ethnic Balance Score for Whites
202. Ethnic Balance Score for Blacks
203. Ethnic Balance Score for Others
204. Ethnic Balance Score for Spanish
205. Births per 100 Females Aged 15-44--3 year Average

GEOCODE--

1. 1970 Census Tract
2. Planning Statistical Area Number
3. CAB Statistical Area Number
4. Planning Area Number (2 Digit)
5. Planning Area Number (3 Digit)
6. Geographic Area Number
7. Building & Safety Area Number
8. Planning District Number
9. Council District Number
10. Statistical Area Name
11. Planning Area Name
12. Geographic Area Name
13. Planning District Name
14. Councilman's Name

APPENDIX D

MATHEMATICS OF CLUSTERING ANALYSIS

Mathematics of clustering

Introduction--

Cluster Analysis is a statistical technique which allows one to organize and analyze a multivariate data set. The data can be arranged in matrix form consisting of n objects (census tracts) each measured on m characteristics or variables. The m x n data matrix is assumed to contain a number of meaningful and relatively homogeneous groupings or clusters of the n objects. An attempt at finding the clusters within the data set can be made through the use of a clustering procedure.

The desirability of using Cluster Analysis as a tool for exploring and analyzing multi-dimensional data is that it allows the data to suggest its own "natural" grouping. These clusters are arranged so that, as far as possible, objects within a cluster are similar to one another as measured by the clustering criterior used. This corresponds to the general intuitive notion that in classification, the groups should be as distinct from one another as possible and, internally, as homogeneous as possible.

Two different clustering procedures were employed in the analysis of the data presented in this report. The first method is a hierarchical approach developed by J. H. Ward.[2] Ward's method is an agglomerative procedure in the sense that once two or more objects have been grouped together to form a cluster they will permanently remain within their original cluster even as it is joined by additional objects or clusters. This technique successively groups together that pair of objects or clusters where the Euclidean distances between cluster centroids (means) is the least. The second method, a non-hierarchical approach, is a variant of the technique developed by J. B. MacQueen.[3] This is a reallocative procedure in that given a number of clusters, objects are sequentially added or withdrawn from their clusters and reallocated to the cluster whose centroid is closest in the sense of Euclidean distance. After each reallocation, the cluster centroids are recomputed and the process continues until no further reallocations are possible.

Hierarchical Clustering--

Ward's hierarchical method of clustering commences by defining a measure of similarity which describes the "closeness" or "similarity" between the objects to be clustered. In this report, the measure used was that of Euclidean distance. Ward's procedure merges together those two objects which are most like each other as determined by the distance from their means and then builds upon this merger until all the objects are grouped. Although Ward's hierarchical clustering process does not have a unique analytical solution, it does produce a unique hierarchy of groupings. At the base of the hierarchy, each object is considered a cluster unto itself while at the peaks all the objects are grouped together into one general cluster.

Ward's procedure utilizes an algorithm in which the mergers at each step in the process are chosen to minimize an error sum of squares objective function. The implementation of this algorithm can be accomplished by defining the following quantities and can be found in more detail in Michael Anderberg's book.[4]

X_{ijk} = the value of the ith variables for the jth object (census tract) in the kth cluster; where $i=1,\dots m$; $j=1,\dots n_k$; $k=1,\dots h$

$\bar{X}_{ik} = \sum_{j=1}^{n_k} X_{ijk}/n_k$ = mean of the ith variables for objects (census tracts) in the kth cluster.

(1) $E_k = \sum_{i=1}^{m} \sum_{j=1}^{n_k} (X_{ijk} - \bar{X}_{ik})^2$ = within group error sum of squares for cluster k.

(2) $E = \sum_{k=1}^{h} E_k$ = total within group error sum of squares for the collection of clusters.

When the clustering process commences there are n objects (census tracts) each a cluster by itself so that the means of each cluster variable are identical to the variable values. Consequently, the within group error sum of squares $E_k = 0$ for all k clusters. Ward's method then selects those two clusters (census tracts) p and q such that the Euclidean distance between them is a minimum. Clusters p and q are then merged to form a new cluster t and the increase (Δ) in the total within the group error sum of squares E can be calculated by using the relationship.

$$(3)\ \Delta E_{pq} = E_t - E_p - E_q.$$

After substituting the identities for E_t, E_p, and E_q into (3) and carrying out some algebra, E_{pq} can be redefined as

$$(4)\ \Delta E_{pq} = (n_p \cdot n_q)/(n_p + n_q) \cdot \sum_{i=1}^{m} (\bar{X}_{ip} - \bar{X}_{iq})^2$$

In this form, the minimum increase in the error sum of squares, E_{pq}, can be seen to be proportional to the squared Euclidean distance between the centroids (means) of the merged clusters p and q. Equation (4) also sufficiently defines the algorithm upon which the hierarchical method of Ward is based.

Ward's method of clustering produces relatively tight clusters which serve as a very good partition of the data set. The results may not be optimal based upon the error sum of squares but usually very little refinement is needed to assume a local optiumum.

Non-hierarchical Clustering--
Non-hierarchical clustering in contrast to the hierarchical approach is designed so that the number of clusters are specified a priori. The basic idea is to choose an initial partition of the data set and then continually refine this partition until no better re-arrangement of the data can be obtained.

The method followed in this study was a refinement of MacQueen's and is termed the Convergent K-means approach. The term K-means is used to denote the process of assigning each entity to that cluster (of K Clusters) with the nearest centroid (mean). The algorithm employed begins with a set of initial points in m-dimensional space, termed seed points or initial cluster centroids. The number of seed points always being equal to the number of clusters wanted. The objective is to allocate each object's allocation the initial cluster centroids are recomputed to reflect the clusters' current membership. This process continues until no more reallocations are made.

The implementation of this method is accomplished through the following steps:

1. Begin with an initial set of cluster centroids $\bar{X}_{ik}$; where $\bar{X}_{ik}$=mean of the ith variable in cluster k.

2. Take each object (census tract) X_{ij} in sequence and compute the squared Euclidean distances to all cluster centroids $(X_{ij} - \bar{X}_{ik})^2$ and assign the object (census tract) to the cluster centroid which is nearest. Then recompute the cluster centroids.

3. Repeat step 2 and if the nearest centroid is not that of the object's (census tracts) present cluster, then reassign the object (census tract) and update the centroids of the losing and gaining clusters.

4. Continue the process until a full cycle through the data set fails to cause any changes in the cluster memberships.

The initial K clusters can be chosen by any method, usually however, results from a hierarchical technique such as Ward's gives a very good initial partition of the data set from which a non-hierarchical approach like MacQueen's can converge quite rapidly. At convergence, MacQueen's technique can be shown to have minimized the toal within group sum of squares, E, for the initial K set of clusters.

APPENDIX E

TAXONOMY OF URBAN ENVIRONMENTAL INFORMATION SYSTEMS

Information

Environmental Category (Air, Noise, Water, etc.)--

Degradation effects-- Health, property damage

Indices-- Standards and goals
    Status measures
    Detrimants of change measures
    Interpolation technique
    Periodicity
    Data gathering
    Computations

Exogenous conditions-- Prediction of status, effects

Polluting sources-- Energy uses, managerial practices, quantity, rate, other volume

Polluting source activity deterimants-- Fuel prices, fuel use efficiency, emission controls, transport alternatives, research and development, power plant operations, land use planning and enforcement, other

Systems

Type (Computerized, manual)--

Data Storage Mode (Tape, disk, etc.)--

Computer System (IBM 370, etc.)--

Database Management--

Data dictionary--

Database administration-- Redundancy control, quality assurance, programmer support, nonprogrammer assistance

Generalized Database Management Systems--

Database structure--

Data retrieval and reporting--

Application program interface--

Update--

Revise--

Integrity-- Back-up and recovery, validation, concurrent update control, access regulation (privacy), encryption, monitoring use and statistics

Data availability--

System Evaluability--

Costs

Operating--

Development--

Systems Analysis

Matrix Analysis--

Classical statistics--

Cluster analysis--

Simulation--

Decision Analysis--

APPENDIX F

GUIDES TO PUBLISHED MATERIAL

Introduction

The information explosion has been particularly acute in the fields of environmental quality and urban land use planning. Books and articles on the subject are issued at a rate that exceeds the digestive capacities of the individual.

In this appendix are listed bibliographic and abstracting books, periodicals and services that deal strictly with environmental matters. These information sources will enable the investigator to find publications on the specific subtopic of interest.

Bibliographies and abstracts are listed for each of the six environmental areas covered in this report. Bibliographies to environmental information in general, to health effects of environment and to EPA publications are also given.

BIBLIOGRAPHY

Air

Air Quality Abstracts. Louisville, KY, Pollution Abstracts, Inc. Summarizes and organizes recent air quality literature in one, 800-page volume. Divided into 10 chapters on emission sources, atmospheric interactions, air quality measurements, control methods, effects on human health and well being, effects on plants, and animals, effects on materials, legal and administrative aspects, basic sciences and technologies, and general aspects.

Air Pollution Abstracts. Research Triangle Park, North Carolina, Air Pollution Technical Information Center, EPA. (Monthly publication).

See also listings under EPA and other Government Bibliographies for air quality bibliographies.

Noise

A Bibliography of Noise for 1971. Compiled by Mary K. Floyd, The Whitston Publishing Co., Inc., Troy, N.Y. 1973. 153 pp.

A Bibliography of Noise for 1965-1970. Compiled by Mary K. Floyd, The Whitston Publishing Co., Inc., Troy, N.Y.

D. M. Lipscomb, Noise: The Unwanted Sounds, Professional/Techn. Series. Chicago, Nelson-Hall Co., 1974. 325 pp.

Water

Water Quality Abstracts, Volumes 1 and 2, Louisville, KY, Pollution Abstracts, Inc. Summarizes and organizes recent water quality literature in two volumes. Divided into six chapters and 40 subchapters. Covers wastewater treatment, industrial wastewater treatment, water treatment, freshwater pollution, optimization and administration, analytical methods. Vol. 1, digests literature published in 1969-72. Vol. 2 digests literature published through 1973.

Oceanic Abstracts. Louisville, KY, Pollution Abstracts Inc. Summarizes, organizes, and indexes the world's technical literature on the oceans. Covers biology, fisheries, geology, oceanography, pollution, engineering, ships, and other major marine-related subjects. Calendar year subscription includes six issues, plus annual cumulative index and hardcover binder. Back issues available on microfilm. Cumulative indexes available in hard copy.

Bibliography of Water Pollution Control Benefits and Costs. Washington D.C., Office of Research and Development, EPA.

See also listings under Environmental Protection Agency Bibliographies, for additional guides to water quality publications.

Land Use

Bestor, George Clinton, and Jones, Holway J. City planning bibliography: a basic bibliography of sources and trends. 3d ed Am. soc. of civil engs. 1972. 53 pp.

Council of planning librarians. Environmental preferences: relevant studies for urban planning, by James D. Harrison. (Exchange bibliog. no. 385) The council 1973. 19 p.

Council of planning librarians. Urban social planning: a selective bibliography, by D. F, Williams. (Exchange bibliog. no. 458) The council 1973. 18 p.

Council of planning librarians, Introduction to Sources of Urban Planning Considerations and Standards, by Linda L. Christensen. (Exchange bibliog. No Sub.) The Council. 1973. 5 p.

Detwyler, Thomas R. and Marcus, Melvin Gerald. Urbanization and environment; the physical geography of the city. Duxbury press, 1972, incl. bibliog.

Robinson, Ira M. ed. Decision-making in urban planning: an introduction to new methodologies. Sage pubs. 1972. p. 597-614.

Land Use and the Environment: An Anthology of Readings, prepared by American Society of Planning Officials, Chicago, under auspices of the Office of R&M, EPA.

Another important source of bibliographic material on this subject is the U. S. Department of Housing and Urban Development.

Solid Waste

Solid Waste Management, Environmental Protection Agency (issued monthly). Contains bibliographic and other information on this subject.

See also the bibliographic references in the Water subsection of this appendix.

Energy

L C Science Tracer Bullet. The reference section, Science and Technology Div., Library of Congress, 10 First Street, S. E. Washington D. C. 20540. Issues bibliographic lists on such subjects as Solar Energy, Geothermal Energy, Biological Effects of Radiation, etc.

Other government agencies publishing bibliographic material on energy are the NSF, FEA, and NERDA.

General Environmental Bibliographies

Bennett, Gary F., and Judith C., Environmental Literature, A Bibliography. Noyes Data Corp., Park Ridge, N. J., 1975. 218 pp.

Design of Environmental Information Systems. Edited by R. A. Deninger. Ann Arbor, Mich., Ann Arbor Science Publishers, 1974. 419 pp.

Environmental Law Reporter, Environmental Law Institute, Washington D. C. 20036.

Environmental Reporter, The Bureau of National Affairs, Inc., Washington D. C.

Environment U.S.A., A Guide to Agencies, People, and Resources, Glenn L. Paulson, Advisory Editor, R. R. Bowrer Company, New York, 1974. 450 pp.

Pollution Abstracts. Louisville, KY, Pollution Abstracts, Inc. Summarizes organizes, and indexes the world's technical literature on the environment. Covers air pollution, water pollution, solid wastes, noise

pesticides, radiation, and general environmental quality. Back issues available on microfilm. Cumulative indexes available in hard copy. Pollution Abstracts Inc., also conducts special searches for literature on specific environmental and marine topics, employing the holdings and staff of the Pollution Abstracts Inc. library. Can provide photocopies of either abstracts of full text documents. Charges based on extent of search photocopying, and staff required.

Seneca, Joseph J. and Taussig, Michael K., Environmental Economics, Prentice-Hall, 1974. (Includes bibliography annot.).

Health Effects

Current Bibliography of Epidemology, published by National Library of Medicine and sold on subscription by the Superintendent of Document, U. S. Government Printing Office, Washington D.C. 20402.

Eutrophication: a bimonthly summary of current literature. Madison Eutrophication Program, Water Resources Center, University of Wisconsin.

Public Health Engineering Abstracts, National Center for Urban and Industrial Health, U. S. Dept. of Health Education and Welfare, 5555 Ridge Avenue, Cincinnati, Ohio 45213. This publication represents a monthly review of more than 800 domestic and foreign journals of science and engineering, reports of State and Federal Governments, and reports and proceedings of scientific research groups. The articles abstracted are selected for their relationship and importance to environmental health. Subjects, authors, and publishers of abstracted articles are cross-referenced in an annual index issue. Reprint requests should be directed to the author or publisher of the complete article.

EPA and Other Government Bibliographies

A Selected List of Translated Non-English Material of Potential Interest to the U. S. Environmental Protection Agency, June 1973. 10 pp.

Air Pollution Translations: a bibliography with abstracts. Information Services Division Series.

Air Pollution Aspects of Emission Sources: A Bibliography with Abstracts. Air Pollution Technical Information Center, EPA. This is a series of bibliographies covering such subjects as pulp and paper production, cement making, electric power generation, and so forth.

An Environmental Bibliography, Editorial Research Section, Office of Public Affairs, EPA, Washington D.C. 20460.

Bibliography of Office of Research and Monitoring Research Reports, EPA, Washington D.C.

Environmental Services (bibliography), U.S.E.P.A., Region VII, 1735 Baltimore, Kansas City, MO 64108. Identifies EPA environmental information services.

Environment, Bibliography of Social Science and Related Literature. Compiled by Denton E. Morrison [and others]. Feb., 1974. 860 pp. Office of R & D, EPA, Washington D.C.

Indoor-Outdoor Air Pollution Relationships: An Annotated Bibliography, ORD, EPA. 1973.

Indexed Bibliography of Office of Research and Development Reports, EPA, Washington D.C.

Odors and Air Pollution, A Bibliography with Abstracts, Office of Air Programs in EPA.

Pesticides Abstracts (monthly). Office of Pesticides Programs, EPA. Rm. EB-49, 401 M Street, S.W. Washington D.C. 20460.

Radioactive Waste Management, bibliography of publicly available literature pertaining to USAEC's Oak Ridge, Tenn. Site, USAEC Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

REFERENCES

1. See "growing seasons" under "Additonal Symbols," this legend.

2. Ward, J. H., Jr., (1963), "Hierarchical Grouping to Optimize in Objective Function," Journal of the American Statistical Association, Volume 58, Number 301, pp. 236-244.

3. MacQueen, J. B., (1967), "Some Methods for Classification and Analysis of Multivariate Observations," Proceedings of the Fifth Berkely Symposium or Mathematical Statistics and Probability, Volume 1, pp. 281-297.

4. Anderberg, Michael R., (1973), Cluster Analysis for Applications, Academic Press, Inc., New York.